

**Assessing Multifunctional Efficiency on cotton and polyester cotton fabrics
with *Pelargonium hybridum* leaf extract**

**By
SHAKTHI.B
(21PTF018)**

**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**

MAY-2023

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Certified as Bonafide Research Work


Signature of the

Head of the Department


Signature of the Guide

DECLARATION

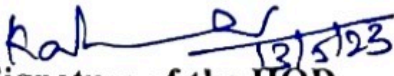
I declare that the dissertation entitled “Assessing Multifunctional Efficiency on Cotton and Polyester Cotton Fabrics with *pelargonium hybridum* leaf extract” submitted by me for the degree of Master of Science (M.Sc.) is the record of work carried out by me during the period from 2022 to 2023 under the guidance of Dr.(Tmt)G.BAGYALAKSHMI M.Sc., M.Phil., Ph.D., Associate Professor, Department of Textiles and Clothing, Avinashilingam Institute for Home Science Higher Education for Women, Coimbatore -642043 and has not formed the basis for the award of any Degree, Diploma, Associate ship, Fellowship, Titles in this University or any other similar institution of higher learning.


Shakti B

Signature of the Candidate

CERTIFICATE FROM THE SUPERVISOR

I certify that dissertation entitled “Assessing Multifunctional Efficiency on Cotton and Polyester Cotton Fabrics with *pelargonium hybridum* leaf extract” submitted for the degree of Master of Science (M.Sc.) Textiles and Fashion Apparel by SHAKTHI B (21PTF018) is the record of project work carried out by her during the academic year 2022 to 2023 under my guidance and supervision and this work has not formed the basis for the award of any Degree, Diploma, Associate ship, Fellowship, Titles in this University or any other similar institution of higher learning


Signature of the HOD


Signature of the Supervisor
with Designation

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Introduction

1. INTRODUCTION

Textile industry has been one of the oldest and most important sectors in Indian economy. It is the second largest employment provider in the country, next to agriculture. Textile industries are facing a challenging condition in the field of quality and productivity due to the globalization of world market. Textiles are developing into inter disciplinary high-tech products. It has become an integral part of everyone's life and is used to envelop and protect human body, thus protecting it from dust, sunlight, wind and other foreign matter present, in the environment. Apparel textile has retained an important place in human life starting from historical era to today modern world (Hemalatha Jain, 2013). The name textile finishing covers an extremely wide range of activities, which are performed on textiles before they reach the final customer. The consumers are now increasingly aware of the hygienic life style, and there is necessity and expectation for a wide range of textile products finished with ultraviolet protecting factor, (Ramachandran et al 2004). Many natural dyes obtained from various plants are known to have antimicrobial properties, (Ramasamy et al, 2011).

With the development of industries the use of chemicals for production and finishing of textiles has also increased. This has enriched the textile production, but on the other hand this has also resulted in environmental issues. The result of pollution caused across the globe has pushed industries to go back into eco-friendly production methods. Every consumer is looking out for bio-degradable products. This has resulted the increased use of natural fibers and plant sources in the medical field. Moreover attraction in natural fibres leads to various design development and application for their eco-friendliness, accessibility, easy production and low cost. An association linking scientist and designer is essential to store the quality resources, fabricate high-quality design and suggests the possible outcomes to consumers and the society in addition to the companies (Suhaily et al., 2013). The increases in the use of chemicals have slowly deteriorated the health of soil and caused severe environment pollution.

The All India Federation of Organic Farming (AIFO) has banned chemicals used in the application of fertilizers, fungicides and pesticides on all agricultural products which also include cotton and all other natural fibers. Eco-friendly concepts are emerging in textiles which lead to eco-revolution (Deo, 2001).

Natural fibres present many advantages like recyclable, biodegradable, plentiful, reveal fine mechanical properties, present improved working conditions and minimum abrasion to equipment in contrast to synthetic fibres, which produce drastic polluting environment (Fazita et al., 2016). Cotton is a service to mankind since ages and its multipurpose functionality is unlimited as new experimentations are constantly being discovered (Corbman, 1983). The most consumed natural fibre is cotton in the world (Singh et al., 2001).

Cotton is a vegetable fiber which is in white or yellowish white obtained from plants (Conway, 1997). Cotton was used for clothing since long and its origin to be traced as 2300 B.C. It has been cultivated for more than 5000 years and archeological finds indicate that cotton was grown and used for textile purposes in the Indus valley well before 2100 B.C. Before 3000 years the cotton yarn was identified in Mohenjo-Daro in Pakistan. In ancient past, people in most of the countries were not aware about the cotton fibre. The climatic conditions of India and the constituents of soil in areas nearby to Indus river were considered as some of the major conclusive factors for the growth of cotton in this part of the globe. Cultivation of cotton in Europe and other parts of world was started around 7th century. Since versatility of its use, it has become popular day-by-day (Nakamura, 2000).

The increasing consumption of fabric and the change in lifestyle have created a demand in production of fabrics that lead the industry to blend natural with various other fibers (Wang et al., 2006). Combination of natural and synthetic fibers generally have different characteristics, which make them ideally suitable mainly for apparel construction. Polyester/Cotton is most popular and common among the blended fabrics and it is used throughout the world in a wide range of fields such as apparel industry, household textile and furnishings, medical items, industrial uses and technical products. This blend exhibit the properties of both fibers providing easy care qualities of polyester as well as the comfort afforded by the moisture absorption characteristics of cotton, but the overall performance depend on the blend ratio.

The combined properties of the polyester/cotton blended fabric, make them a sole choice of material for textile with added functionalities. These advantages permit an increased variety of products to be made, and yield a stronger marketing advantage. Also, polyester/cotton can be easily functionalized and suitable for lots of high end applications.

Plants contain good source of compounds which exhibit antimicrobial properties and it can be used in taking care of a range of illness. The growth of microbes is controlled when plant extracts are used in textile finishing. Therefore both textiles and antimicrobial property in plants is capable of combining together to increase benefits. A general lack of knowledge on conventional medicines, joined with the wish for a “natural” life style has ended in an escalating consumption of substitute or balancing therapies with the help of natural products in general and phytomedicines in particular (Zaheer et al., 2011). The application of medicinal plant research is a booming segment of scientific and research community (Heinrich, 2000).

Antimicrobials usage were identified for preserving of mummies in ancient Egypt. During 1867 the earliest antimicrobial textile material was build up by Lister. Now there has been an gaining attention in antimicrobial finishes (Pannu, 2013). The awareness of safeguarding from microorganisms started at some point in World War II when researches started emerging to discover new appropriate antimicrobial finish. During that time, the antimicrobial finishes were initially applied for tents, tarpaulin and automobile wrap from decomposition (Mudnoor and Laga, 2012).

Plant resources have a lead role in natural antimicrobial agents as they can be incorporated onto fabric for their antimicrobial potentiality. Many have worked on natural antimicrobial agents but only few have exploited combinational herbal extract coating on fabrics (Kongarasi et al., 2016). Many Studies relate that the antimicrobial potential of plant extracts are due to their secondary metabolites. These metabolites are the reason for plants resisting the attack of microorganisms since immemorial (Abdallah, 2011). Today consumers demand more durability, and functionality from their clothing. In recent years great interest is shown on the development of innovative technologies for producing protective clothing which offers enhanced comfort and protection to the wearer.

Protective clothing refers to garments and other fabric related items designed to protect the wearer from hazardous environment. The most prevalent hazard encountered in everyday life is the threat from the natural environment. The hazards include heat, cold, rain, snow, wind, abrasion, dust, microorganisms, nuclear radiation, the effects of static electricity and ultraviolet rays. These can cause problems during occupational, recreational and routine activities. Hence protective clothing is now a major part of textiles and classified as technical or industrial textiles.

Apparel manufacturer and the finishing industry are thus faced with a daunting job of producing superior fabrics that are technically advanced. Today's requirement is no longer about spinning, weaving or knitting but rather about flexible material engineering. Yarn and fabric producers and finishers too must be extremely well informed about the materials to be processed. It is essential to know how these materials will perform in the sun, wind and rain. The solar radiation that reaches the earth surface consists of infrared, visible light and ultra violet rays.

Solar radiation including its ultraviolet component has always been an important environmental factor for life on earth. Exposure to minimal doses of sunlight is beneficial for organisms since it contributes to the development of bones and the assimilation of vitamins. With less atmospheric ozone, a higher level of Ultraviolet light reaches the earth surface. The level of UV light today is higher than it was 50 or 100 years ago.

The ultraviolet rays are normally filtered in the atmosphere, but with the depletion of ozone layer by continued atmospheric pollution caused by industries, the UV rays are not blocked. Over exposure to the sun increases the risk of permanent damage to the skin caused by Ultraviolet radiation. In the last two decades, the media and the scientific community have highlighted the depletion of the ozone layer and the resulting elevation in the levels of ultraviolet radiation (UVR) reaching the earth's surface. UV radiation can be divided into three categories, dependent on wavelength: UVC, 200-280nm; UVB, 280-315nm; UVA, 315-400nm. Each one percent decrease in ozone concentration is predicted to increase the rate of skin cancer by two percent to five percent. Thus it is important to protect the human being from excessive exposure to UV radiation.

Repellents come under the class of insecticides. Insecticides are broadly classified into two types. They are contact insecticides and repellent insecticides. Repellents are substances that are mainly used to repel insects and pests rather than causing death. Several mosquito repellents are available today in the market of which DEET is safely used by an estimated 110 million people worldwide each year (Gopalakrishnan, 2006).

Mosquito repellent textiles are one of the revolutionary ways in advance. The textile field provides the much needed features of driving away 11 mosquitoes, especially in the tropical areas. There are many chemicals available for achieving mosquito repellent on textiles.

But most of the chemicals are banned from the World Health Organization (WHO) due to their harmfulness towards the environment. Therefore, researchers have shifted their focus towards natural mosquito repellent compiled with the requirements of WHO (Debboun et al., 2007). Mold, mildew, fungus, yeast, bacteria and virus are part of our everyday life and found everywhere in the environment (Ana et al., 2010). Natural herbs carry herbal property will be beneficial to the human body (Deepak et al., 2011). Microbial biomasses and the various extracts that can be obtained from these sources (Bruno et al., 2010).

Some of the herbal compounds obtained from plants are well known from time immemorial as anti-bacterial products. These plant products are applied directly on skin or wounds as paste or incantation either for skin care or wound healing. These natural products are abundantly available in nature and are widely distributed and the part of these plants applied to textiles. They are cheap and not processed and can be used as raw material required for applications. Apart from dyeing, these medicinal products possess distinct odour for identification and these are non-irritant to skin and non-toxic. Considering these aspects in mind the present study on “**Assessing Multifunctional Efficiency on Cotton and Polyester Cotton Fabrics with *Pelargonium hybridum* leaf extract**” compared to identify the effect of the fabrics against the skin infective pathogens with the following objectives;

- To assess the multifunctional effect of selected extract
- To optimize the concentration of selected plant extract for finishing of Cotton and Poly Cotton
- To treat Cotton and Poly Cotton fabrics with plant extract
- To evaluate the treated Cotton and Poly Cotton fabrics

Review of literature

2. REVIEW OF LITERATURE

The review of literature pertaining to the study on “**Assessing Multifunctional Efficiency on Cotton and Polyester Cotton Fabrics with *Pelargonium hybridum* leaf extract**” consist of following headlines

2.1 ORGANIC COTTON

2.1.1. History of Organic Cotton

2.1.2. Properties of Organic Cotton

2.1.3. Benefits of Organic Cotton

2.2 POLY COTTON

2.2.1 Polyester/Cotton Blended Fabrics

2.3 FINISHING

2.3.1 Need for textiles finishing

2.3.2 Bio finishing of textiles

2.3.3 Special finishes on textile products

2.4 PLANT EXTRACT

2.4.1 *Pelargonium hybridum* leaf

2.4.2 Properties of *pelargonium hybridum*

2.5 ANTIBACTERIAL FINISH

2.5.1 Antibacterial Finish on textile products

2.5.2 Properties of Antibacterial Finish

2.5.3 Requirement of Antibacterial Finish

2.6 MOSQUITO REPELLENCY

2.6.1 Requirements for Mosquito Repellent Finish

2.7 UPF

2.7.1 Classification of UVR

2.7.2 Textiles as Protection from Ultraviolet Radiation

2.7.3 Sun Protective Clothing

2.1. Organic Cotton

Organic cotton is generally understood as cotton, that is not genetically modified or the one which is grown without using any synthetic agricultural chemicals. Organic cotton support biodiversity and ecological conservation (Mussig, 2014).

2.1.1. History of Organic Cotton

The concept of organic agriculture builds on the idea of the efficient use of locally available resources as well as the usage of adapted technologies (e.g. soil fertility management, closing of nutrient cycles as far as possible, control of pests and diseases through management and natural antagonists). It is based on a system-oriented approach and can be a promising option for sustainable agricultural intensification. Organic cotton is naturally cultivated which does not use any chemicals, fertilizers or pesticides. The first attempt was made during 1980s to plant organic cotton for sustainability, ecological conservation and biodynamic agriculture. It provides lot of benefit to human as well as environment. Even though it has cost constraints it's stillleaping in bounds in the market for their uniqueness (Sinclair, 2014).

2.1.2. Properties of Organic Cotton

There are lot of specifications for Organic cotton properties and they are coined for "Green" apparel goods in Europe and North America. The cost of Organic cotton varies from Conventional cotton due to maintenance, activity based and transaction cost (Sarkis, 2017)

2.1.3. Benefits of Organic Cotton

Organic cotton offers various benefits for all stages of the value chain including farmers, dealers, seller and customers. It also has every advantage encompassing each sector like the financial, communal and ecological return in the development of organic cotton. The following are the merits rendered to farmers

- a. Preservation or development of soil fertility,
- b. Safeguard health,
- c. Enhancement of financial situation and food safety
- d. Way in to lively markets and
- e. Efficient logistical and technological support from producer organisations and networks.

The advantages for customers are procuring eco-friendly products, standard goods, clear production methods and composition, apparent market information and more susceptible and constructive idea developed for the environment and as well manufacturers' living (Adanacioglu and Olgun, 2012)

2.2.1 Polyester/Cotton Blended Fabrics

Cost, quality, care and comfort are the significant properties that the customer considers before buying a cloth, all of which are different aspects of Comfort. Cotton fabrics are in use for hundreds of years because of the quality, consistency and air permeability (Ravandi & Valizadeh, 2011). There are numerous drawbacks in using pure cotton fabric, which is solved by blending cotton with polyester. Blending the fibers in a fabric seems to be a powerful solution to modify the properties and cost of the materials. The polyester fabric has attained its reputation because of its soft finish and its tendency to easily merge with other cloth materials. Cotton has high moisture retention, and so it absorbs sweat and lets it evaporate; therefore cotton is highly water-vapor permeable or breathable. Polyester has low moisture absorbency and it is not breathable, but is crease resistant; cotton is not. So, when cotton is blended with specific percentage of polyester, we get the finest of both the fabrics, and the finished goods are durable too. Polyester/cotton fabric is probably the most famous and popular blend. The fibers of polyester and cotton have the largest production volumes globally and will fulfill the demand in apparel and clothing, sportswear, healthcare, medical textile, home textile and other technical fields (Mather & Wardman, 2011). Healthcare textile comprises surgical clothing (surgical gowns, head caps, masks, uniforms, etc.), surgical covers (drapes, Coversm, etc.) and beddings (bed spreads, blankets, pillow cases, etc.). The combination of cotton/polyester blend results in a soft, absorbent material with just the correct amount of stretch for manufacturing fabric like sleepwear, undershirts, etc. One of the most important characteristics of the fabric which affects the comfort properties of cloth is the constructional specification (Ravandi & Valizadeh, 2011). There are many ways of making fabrics from textile fibers, among which woven fabrics generally have smoother surface and are flexible, strong and porous which makes them useful in clothing, apparel and technical applications with minimum production costs (Dubrovski, 2010). Hence, the plain woven polyester/cotton blended fabrics were used in this study.

2.3 TEXTILE FINISHING

2.3.1 Need for textiles finishing

"Finishes are those end processes which are undertaken to change the form and appearance of fabric after their manufacture." (Gupta 2013) Finish is anything that alters the hand appearance or performance of a fibre, yarn, or fabric. Interestingly enough a finish is not done at the end or in the final stage of textile production, although it can be. Frequently it is a preparatory process that is done at the fiber stage of the textile production process. (Colussy, 2007) 'Any operation for improving the appearance or usefulness of a fabric after it leaves the loom or knitting machine can be considered a finishing'. (schindler, 2004).

2.3.2 Need for finishing

Different finishing is given to the fabric keeping in mind the purpose. It enhances the desired properties in the fabric. Hence the purposes of finishing are important and enhance the appearance the utility of fabric, to bring variety, durability, and also to produce imitation fabric. (Gupta 2013) Finishing is the final operation carried out after dyeing or printing to impart smoothness to the fabric and resistance to wear. Finishing is also necessary to make a fabric wrinkle resistance, crease retentive, moth proof and mildew resistance (Manivasakam, 1995). Finishing techniques is an outgrowth of techniques of the manufactures difficulties in making wrinkle resistant goods into garments. The finish given to the fabric is a built-in 'memory' which interfered with shaping garments to conform to body contours, pressing creases into trousers and putting pleats in skirts, (Sing, 2004). Water for finishing requires being as free from compounds of calcium, magnesium and iron as possible, for the presence of the salts of those metals either together or separately has a deleterious action, (Edge, 1998). The aim of the textile finishing is to render textile goods fit for the trend use, (Nalankilli, 1997).

2.3.2. Classification of finishing

The term textile finishing means completing the manufacture of cloth by surface treatment. In broad sense, it covers all the treatments it undergoes after leaving the loom or the knitting machine till it enters the market and includes processes like bleaching mercerizing, dyeing and printing, (Prayag, 1994). Finishing at the garment stage is more difficult as it sets boundaries on the process techniques. It is prime importance to selected processes which can be applied in the exhaust or by spraying, (Joshi et al., 2001).

As many process and machines such may be described generally prior to a particular description of the finishing operation necessary for representative fabric. Mending knotting and burling, souring, milling and crabbing. (Board, 2003). Finishing is the last stage of fabric processing. It covers a wide range of processes which make an unattractive, 'greige fabric turn into an attractive one. It is possible to carry out finishing at different stages of textile production. Thus a fibre, yarn, fabric or garment can be subjected to the finishing process, through most efficient results are obtained at the fabric stages. (Sekhri, 2012). When fabrics have been constructed, they are called grey goods. Before they can be used to manufacture products, they need to go through one or more finishing processes. These processes are designed to alter the appearance of a fabric and/or its performance properties. The different finishing process can be grouped together according to how they are carried out. (Lawler, 2002) Most functional finishing technologies employed in textile treatments are based on direct incorporation/reaction/binding of functional agents to textiles (e.g. antimicrobial agents, fire retardants, antistatic agents, UV blockers, water/oil repellents, etc.). Recently, these functional finishes are being developed and applied after appropriate modification (chemical or physical) to enhance their activity. (Gulrajani, 2013).

2.3.3 Special finish on textile products

Special finishes include antibacterial, fragrance, UV resistant, flame retardant and many others. Special functional finishes represent the next generation of the finishing technology, (Menezes and Choudhari, 2007). Functional apparels have added values with specific end uses, (Kumar and Teli, 2007). Functional textiles and clothing provide the expected against cold, easy care, as well as some new properties and functions of thermo-conductivity, UV protection, deodorant, avoidance of unpleasant odour, antibacterial and antifungal protection, (Coman , 2010). The new developments in the special finishing sector are driven by consumers' changing lifestyle towards a more casual clothing look, with a greater performance for higher standard of aesthetics, comfort, health and safety, protection and easy care performance, (Mendapara and Karolia, 2005). Apart from the innovations in fabrication, application of functional finishes to garments, such as fragrance, antibacterial, UV and antifungal finish, add up more value to the end product in the current market scenario, (Julio and Andrew, 2007). Finishes that are applied to a fabric to make them better suited for specific uses come under this category.

It improves the performance of specific purpose. Many times functional finishes may or may not be seen by looking at the fabric, (Gupta, 2005). Finishes serve a significant purpose in the overall performance or function of the fibre, yarn or fabric. Buyers always expect a high degree of wearing comfort and finishing plays an important role in achieving that in the recent years. The new developments in speciality finishing sector are driven by consumers changing lifestyle towards a more casual clothing look, with a greater performance for higher standard of aesthetics, comfort, health and safety, protection and easy care performance, (Karolia , 2005).

2.4 PLANT EXTRACT

Green methods of synthesis refer to those in which microorganisms, enzymes, and plant extracts are used in the fabrication process. No toxic materials should be used, and the process is combined with low energy consumption. It has the advantages of environmental sustainability, eco-friendliness, and low cost, and is therefore an attractive alternative to traditional physical and chemical methods. extracts from leaves, peels, roots, flowers, fruits, and seeds of plants can act as both reducing and stabilization agents for the synthesis of ZnO NPs The green synthesis of ZnO NPs from plant extracts results in excellent antibacterial activity against a variety of bacteria, greater than that observed with chemically synthesized ZnO NPs, without antibiotic resistance. They are non-toxic and compatible with skin, and therefore are suitable for use as additives of products designed to be in contact with the human body. Based on these characteristics, the green synthesis of ZnO NPs from plant extracts can be further used for textiles, adding antibacterial functionality whilst maintaining environmentally-friendly development.

2.4.1 *Pelargonium hybridum leaf*

Nicknamed the “florists’ geranium“, “queen of the windowsills“, and even confusingly simply “geranium“, storksbill or pelargonium is a perennial plant native to South Africa that grows in sun-endowed regions and resists winter frost spells. An annual plant, storks bill is a shrub with tuberous roots, and depending on the variety, the stems can be fibrous or subsucculent, herbaceous or succulent. It hosts very colorful flowers; alternate leaves that are whole, gouged or even composite. As for its fruits, they’re formed into a long beak (central axis) and five mericarps with an ellipsoid feather-like seed: this looks decidedly like the beak of a stork. This bush is usually very fragrant, grows in rich soil mix that should be light, airy and should drain very well, as are most garden soils where there are a lot of leaves.

It has been sighted virtually all over the planet, even in deserts. This versatility serves it well, given the diversity that it shows as a species. However, aside from its ornamental purpose, Pelargonium has been playing a major role in traditional medicine, especially in Africa.

2.4.2 Properties of *pelargonium* leaf

Pelargonium health benefits and therapeutic properties for centuries, storksbill was used in modern herbal medicine by such tribes as the Fingos, Xhosas, Zulus and Basothos. Indeed, the herbal medicine practitioners were aware of its medicinal properties, and recommended pelargonium roots to help reduce symptoms of respiratory infections, among which were included pneumonia, sinusitis, cough, pharyngitis, sore throat and common colds. Moreover, this perennial plant was called upon to prevent secondary infections like chronic bronchitis. In most cases, pelargonium was used as a substitute for antibiotics in some of these disorders. To better understand the sanitizing effects of Pelargonium, note that this plant acts upon micro-organisms that have taken hold in the lungs and higher breathing tracts; the result is that breathing becomes easier in case of bronchitis or other respiratory infections. This plant is very often recommended in winter, when low-level sore throats and respiratory disturbances reappear. Aside from that, pelargonium is recommended in cases of exhaustion, stress, and apathy, because thanks to its therapeutic properties, it has the capacity to reinforce the immune system. Usage, dosages, and how to use pelargonium“*Pelargonium sidoides*” is sold as extract to treat bronchitis and colds. Recommended dosage when using extracts are best found on the manufacturer’s information sheet. gelcaps/tabs to treat colds. 2 capsules (400 mg each) taken morning and evening are recommended. For children ages 6 and above, dose must be halved and finally as tincture. Usual recommended dosage is 1 teaspoon (5 ml) taken 3 to 4 times a day. Practical advice regarding Pelargonium is recommended to treat bronchitis, colds, the flu and even sinusitis; and its extracts are usually well tolerated.

Take note though that certain patients did report that skin rashes, slight stomach pain and disorders of the nervous system were felt after having ingested pelargonium root extracts. Consequently, using pelargonium root extracts during pregnancy and breastfeeding is not advised. Absorbing pelargonium should never replace actual doctor-prescribed treatments. It is usually prescribed as an additional treatment.

2.5 ANTI BACTERIAL FINISH

2.5.1 Anti bacterial finish on textile products

Microbes such as bacteria, virus, fungi and yeast are present almost everywhere. Human beings have an immune system to protect against accumulation of microorganisms, materials such as textiles can easily be colonised by high number of microbes or even decomposed by them, (Dorugade and Bhagyashri, 2010). The word antibacterial is a general term for any product that kills or controls microbes, (Srikanth, 2010). Germs grow very rapidly by cell division, doubling their population every 20 minutes. They require humidity and an organic medium for growth. Antibacterial finishing of textile fabrics prevent the growth of various microorganisms and therefore, contribute to deodorising. Antibacterial finishing products are divided into bactericides (causing destruction of bacteria) and bacteriostats (inhibiting bacterial growth), (Toshniwal et al., 2009). Generally, there are two types of anti bacterials available in market, Leaching type (Controlled release type) and non-leaching type (Bound anti bacterials), (Patel and Desai, 2014). Nowadays antibacterial material that can create comfortable living environment has attracted more and more attention, (Chen, 2010). The increasing demand for comfortable, aesthetic, durable, functional and safe textile products dictates to develop of new and contemporary techniques of processing and designing textiles, (Tomsic et al., 2008). The textile materials are good media for protecting us from microorganism. Among various functional abilities, the antibacterial property is considered to be important with fabrics, which are in direct contact with human body, (Sathinarayanan, 2010). The protective aspects of textiles have provided the most textile ground for innovative developments.

Hygiene has acquired importance in recent years. Odour has become an important factor and consumers are looking for solution to odour and microbial problem and unique benefits provided by the antibacterial finish. Bacteria and fungi are especially likely to grow on hydrophilic fibres under moist, warm conditions. In order to stop their growth, bacteriostats are applied during dyeing, (Rajendran et al., 2009). The highest level of hygiene is sometimes difficult to achieve because of microorganisms which are part of our everyday life. (Asanovic et al., 2010).

2.5.2 Properties of anti bacterial finish

Anti-bacterial finish maintains hygiene and freshness and stops bad odor from the surface of the fabric. Controls or eliminates microbial staining and improves the life of the articles wherever it is applied. Improves hand of most of the fabric, eliminates the chances of disease transmission and is effective on any substrate like cellulose, synthetics as well as their blends and any surface other than textiles (Ganesan et al., 2008). Anti-bacterial finishes add value to textiles and protect the wearer or user of a textile against bacteria, yeast. Fungi and other related microorganisms for aesthetic, hygienic or medical purposes. It protect the textile against bio-deterioration caused by mould, mildew and rot producing fungi and protect the textile from insect and other pests for preservation of the fibre / or protection if persons wearing clothing from insects and pests. Anti-bacterial finish properties are to control the infestation by the microbes and to arrest metabolism in microbes and to protect textiles from staining discoloration and quality deterioration and prevents the odor formation (Ramachandran et al., 2004). This finish should prevent the transfer and spread of disease promotes (Achwal et al., 2003). Anti-bacterial finish should not be toxic to the human body and should be compatible with other finishes (Parthiban, 2006). This finish maintains hygiene and freshness and it control or eliminates microbial staining to stop skin irritation (Menezes, 2004). It eliminates the chances of disease transformation and it is effective on any substance like cellulose, synthetics as well as their blends and any surface other than textiles (Srivastava, 2010).

2.5.3 Requirement of anti bacterial finish

Textile material in particular, the garments are more susceptible to wear and tear. It is important to take into account the impact of stress, strain, thermal and mechanical effects on the finished substrates. According to Vishnu and Bagya (2010) finishes should preferably be compatible with textile chemical processes such as dyeing is cost effective and not produce harmful substances to the manufacturer and the environment. It should not kill the resident flora of non pathogenic bacteria on the skin of the wearer. Finishing should have acceptable moisture transport properties and should be easy to apply (Gaurav, 2005). The finish should be resistant to body fluids and to disinfection / sterilization.

The following requirements need to be satisfied to obtain maximum benefits out of the finish.

- Durability to washing, dry-cleaning and hot pressing.
- Selective activity of undesirable microorganisms.
- Should not produce harmful effects to the manufacturer, user and the environment.
- Should comply with the statutory requirements of regulating agencies.
- Compatibility with the chemical processes.
- Easy method of application. No deterioration of fabric quality.
- Resistant to body fluids and resistant to disinfection / sterilization.

The growth of microbes is rapid. The bacteria population for example, doubles every 20 to 30 minutes under ideal conditions. Therefore anti-bacterial finishes must be quick acting to be effective (Shukla and Sundar, 2008). Anti-bacterial treatment of textile material is necessary to fulfill the following objectives.

- To avoid cross infection by pathogenic microorganisms.
- To control the infestation by microbes
- To arrest metabolism in microbes in order to reduce the formation odour
- To safeguard the textile products from staining, discoloration and quality deterioration (Gopalakrishnan, 2006).

2.6 MOSQUITO REPELLENT

According to Benard (2000) mosquito repellents may be one of the most effective tools for protecting human from vector borne disease such as dengue hemorrhagic fever, malaria, encephalitis and filariasis as well as the nuisance caused by mosquitoes. In 1999, the conference of insect proof process was established and the method of the insect proof test and qualifying standard was decided (Nakamura and Basmatkar, 2005). Mosquitoes cause annoyance and spread human and animal disease. The task of managing and treating large areas by spraying insecticides for controlling these pests is uneconomical and undesirable from an environmental standpoint. Application of insect repellent directly to the skin gives protection for only a few hours because it is lost by evaporation, abrasion and absorption.

The application of insect repellent to textiles is an alternative that provides long lasting protection (Shroff, 2001). Repellents are used rarely by the community to prevent mosquito bite. They contain synthetic or natural active substances of substantially varying effectiveness.

2.6.1 Requirement for mosquito repellent finish

The distribution of mosquitoes has expanded from tropical regions to northern latitudes due to global warming and that leads to a spread in source of viral infection from mosquitoes. Especially, the West Nile fever virus which has infected many people around the world recently. The virus, bacteria and fungus are being arrived via wild birds imported as pets and via plane or boat in an infected mosquito. The populations of mosquito are found to be enormous day by day. The need is for finishing textile products to protect against mosquito-transmitted viral infections such as malaria, pneumonia and other diseases (Kumaravel and Kantha, 2009).

2.7 ULTRAVIOLET PROTECTING FACTOR

The UV radiation affects nearly all living organisms. Both the US Department of Health and Human Services and the World Health Organization have identified UV as a proven human carcinogen. UV radiation is considered as the main cause of Nonmelanoma Skin Cancers (NMSC) including Basal Cell Carcinoma (BCC) and Squamous Cell Carcinoma (SCC). These cancers strike more than million each year express Gambichler et al. (2001). UV radiation is harmful to human health.

The risk posed by Ultraviolet Radiation has become more dangerous in recent years as the entire world is suffering from all kinds of pollution states Singh (2005). The incidence is further expected to increase at an annual rate of 7-10% per annum with next few years, reveal Jhaver et al. (2007). The demand for data on solar UV radiation has markedly increased, says Dubrovski and Golob (2009).

2.7.1. Classification of UVR

The solar radiation that reaches the earth surface consists of infrared, visible light and UV radiation. UV radiation is electromagnetic radiation of a wave length shorter than that of the visible region, but longer than that of soft X-rays.

These radiations differ in its effect at different lengths having harmful as well as helpful effects say Malik and Arora (2003). UV radiations are classified by wavelength into three categories says Perenich (1998).

Classification of Ultra Violet Radiation

UVA

UV radiation on the range 315 to 400nm which generally contribute to premature ageing of skin, accounts 90% total UV radiation that reaches the earth surface. It can penetrate into the deeper layers of the skin and are implicated in premature ageing, wrinkling and causes skin allergies and rashes say Gupta et al. (2002). UVA rays are present during all day light hours and through out the winter months. UVA radiation can penetrate glass and clouds. Recently scientists have learned UV rays probably play a vital role in wrinkling, spotting, lost elasticity. They believe that less of it was absorbed by DNA causing fewer dangerous mutations. UVA damage is a more constant threat report Painter (2007).

UVB

UVB is the middle range of UV with the wavelength between 290- 320nm. The UVB rays on the skin can lead to acute and chronic reactions. It is more dangerous than UVA and has been implicated as the major cause of the skin cancers, skin reddening or sunburn, increased risk factor for persons susceptible to melanoma, eye damage and play contributory role in tanning and photo aging and the intensity of UVB varies by season, location and time of the day say Purushotham (1998) and Verschooten et al. (2006).

The effect of UVB to skin is as from 100 to 1000 times as UV-A reports Nakamura and Basmatkar (2005) and Kullavanijaya and Lim (2005).

2.7.2 Textiles as protection from ultraviolet radiation

The textile protection of human skin against UV radiation is very important problem and over recent years researches have shown increasing interests in this area say Duleba-Majek and Malgorzata (2009). Apart from drastically reducing exposure to the sun, the most frequently recommended form of UV protection is the use of sunscreen, hats and proper selection of clothing.

Because fabric is composed of fibres that can absorb, reflect or scatter radiant energy, it has the ability to absorb or block most of the incident radiant energy and prevent it from reaching the skin explain Capjack et al. (1994). Ultra violet transmittance of a fabric depends mainly on the amount of ultraviolet radiation passing through the voids formed between interlaced warp and weft yarns and on its potential to pass through fibres say Algaba et al. (2004).

Textiles are translucent materials, which diffuse the incident light. Part of the light is absorbed, a part is reflected and a considerable quantity of light is transmitted. The ratio of the total transmitted light to the total incident light is known as transmittance of a fabric. If a fabric has high transmittance values, then it has less ultraviolet transmittance of fabrics and vice-versa say Sunder and Kumar (2005).

2.7.3 Sun protective clothing

Protective clothing is clothing designed to protect either the wearer's body or other items of clothing from hazards such as heat, chemicals and infection. Fabrics and garments are now being engineered to maximize the amount of UV protection they provide and are used to make solar protective garments reports Carol Beard et al. (2000). The definition of a sun protective fabric is a fabric that must achieve a minimum of UV protection factor rating of at least UPF 15 after the equivalent of two years of normal wear and tear (<http://dermneting.org/treatments/sunprotective-clothing.html>). Adequately labeled sun protective clothing offers millions of Americans the opportunity to significantly improve the quality of their lives and is an essential step in eliminating skin cancer in our world feel Edlich et al. (2004).

Sun protective fabrics typically have a tighter weave or knit usually are darker in colour. Garments made with these fabrics may have a label listing the garments UPF value. Dermatologists are of the opinion that suitable clothing is more effective protection against UV radiations than applying protective sun screens expresses Achwal (2003). High quality sun protective clothing from reputable manufacturers typically blocks over 97 percent (SPF/UPF 30+) of UVA and UVB rays. Slapping on sunscreen is no substitute for covering up. Sunscreen need to be reapplied periodically. The cost and convenience of sunscreen remains an issue, as does an understanding of the limitation of sunscreen use and the correct application of it say Eadie and Mac Askill (2007).

Experimental procedure

3. EXPERIMENTAL PROCEDURE

The experiment procedure relating to the study on “**Assessing multifunctional Efficiency on Cotton and Polyester Cotton fabrics with *Pelargonium hybridum* leaf extract**” has been carried out as presented in the following aspects.

3.1 SELECTION OF FABRIC

3.1.1 Preparation of Fabric

3.2 SELECTION OF SOURCE

3.2.1 Collection of source

3.2.2 Plant Authentication

3.3 EXTRACTION FROM *PELARGONIUM HYBRIDUM* LEAVES

3.3.1 Selection of Extraction method

3.3.2 Phytochemical test

3.3.4 Anti bacterial test

3.3.5 Toxicity test

3.4 SELECTION OF APPLICATION METHOD ON FABRICS

3.4.1 Boiling Method

3.4.2 Dip and Dry Method

3.5 OPTIMIZATION PROCEDURE FOR FINISHING

3.5.1 Determination of optimum concentration for finish on fabric

3.5.2 Determination of optimum time for finish on fabric

3.5.3 Determination of optimum temperature for finish on fabric

3.6 COST ESTIMATION

3.7 NOMENCLATURE

3.8 EVALUATION

3.8.1 Objective evaluation

3.8.1.1 Fabric Weight

3.8.1.2 Fabric Thickness

3.8.1.3 Tensile strength and elongation

3.8.1.4 Abrasion resistance

3.8.1.5 Fabric Stiffness

3.8.1.6 Colour Fastness to rubbing (dry & wet)

3.8.1.7 Sinking test

3.8.1.8 Wicking test

3.8.1.9 Spray test

3.8.2 Ultra Violet Protecting Factor

3.8.3 Mosquito Repellent

3.1 SELECTION OF FABRIC

Cotton has high value due to aesthetics, its pleasant texture and mattelook. Because of its high capacity to absorb, hold and dry moisture, cotton offers maximum comfort under extreme heat and humidity. It is a preferred fabric for children and for anyone who has a sensitive skin and is allergic to other fibers. Since cotton is non-allergenic (Sekhri, 2012). The investigator has selected cent percent fabric and procured the same fabric. In Poly cotton — sometimes known as poly cotton or poly-cotton — is a blend of natural cotton and synthetic polyester. The blend mixes cotton fibers with artificially made polyester fibers. Usually, the mix has a ratio of 65% cotton and 35% polyester. Poly cotton fabrics are breathable, tear-resistant, and can be fashioned into abrasion-resistant fabrics, like canvas.

3.1.1. Preparation of Fabrics

Desizing is an essential step in the cotton manufacturing process. Sizes are merely the starch that must be removed before colouring is applied to woven fabrics made of warp yarns in order to help them resist the weaving process. The process of "desizing" involves taking the starch out of the fabric. Sizing material must be removed from cotton warp yarns and fabric. The size of these strands is designed to prevent them from breaking under the pressure and tension of weaving. The fabric contains both natural and synthetic fibres, and other foreign materials are eliminated during the process because starch prevents dye from penetrating fibre. To remove starch from the fabric, a variety of processes are utilised. To remove the sizing material from the chosen cloth, it was boiled at 100°C for one hour. (Wadje, 2009). Selected cotton fabric was desized using the recipe given below. (Plate)

Recipe:

ML Ratio: 1:30

Soap nut extract -10%

Extract of ash water – 10%

Temperature – 100° C

Time – 1hr

3.2 SELECTION OF SOURCE

3.2.1 Collection of Source

The *Pelargonium hybridum* leaf (Plate-I) is collected from the Horticultural Research station, which is located in Udhamandalam (Ooty) hill stations.

3.2.2 Plant Authentication

The plant specimen given for authentication is identified as *Pelargonium x hybridum* (L.) L'Hér. (Syn.: *Geranium x hybridum* L.) - **GERANIACE** from Tamil Nadu Agricultural University (TNAU), Coimbatore.

3.3 EXTRACTION FROM *PELARGONIUM HYBRIDUM* LEAVES

3.3.1 Selection of Extraction Method

For extraction, washed 2kg leaves of *pelargonium hybridum* and ground the wetted leaves in mixer grinder. After grounding, using grey fabric on the top of the bottle, pour the ground substance in the cloth. And squeezed it, thus the liquid substance of *pelargonium hybridum* was extracted. About 2 liters extract was obtained. The extract was stored in an airtight container(Plate-2)

3.3.2 Phytochemical Test

Phytochemical Analysis of Herbal Extract Qualitative phytochemical analysis of each of the herbal extract was carried out on the leaf extracts using different solvents such as Hexane, Ethyl acetate and Methanol to identify the major natural chemical groups such as carbohydrates, tannins, saponins, flavonoids, alkaloids, quinones, glycosides, cardiac glycosides terpenoids, phenols, coumarins, steroids and phytosteroids, phlobatannins and anthraquinones as per the procedures given below(Plate-v) results from Bharat Rata prof.CNR Rao Rese.arch center, Avinashilingam University.

3.3.2.1 Test for Carbohydrates

To the plant extract of 2ml, 1ml of Molisch's reagent and few drops of concentrated Sulphuric acid were added. Presence of purple or reddish colour indicated the presence of carbohydrates.

3.3.2.2 Test for Tannins

To the plant extract of 1ml, 2ml of 5% ferric chloride was added. Formation of dark blue or greenish black indicated the presence of tannins.

3.3.2.3 Test for Saponins

To the plant extract 2ml, 1ml of distilled water was added and shaken in a graduated cylinder for 15minutes length wise. Formation of 1cm layer of foam indicated the presence of saponins.

3.3.2.4 Test for Flavonoids

To the plant extract 2ml, 1ml of 2N sodium hydroxide was added. Presence of yellow colour indicated the presence of flavonoids

3.3.2.5 Test for Alkaloids

To the plant extract of 2ml, 2ml of concentrated hydrochloric acid was added. Then few drops of Mayer's reagent were added. Presence of green colour or white precipitate indicated the presence of alkaloids.

3.3.2.6 Test for Quinones

To the plant extract of 1ml, 1ml of concentrated Sulphuric acid was added. Formation of red colour indicated the presence of quinones.

3.3.2.7 Test for Glycosides

To the plant extract of 3ml, 3ml of chloroform and 10% ammonia solution was added. Formation of pink colour indicated the presence of glycosides.

3.3.2.8 Test for Cardiac Glycosides

To 0.5ml of extract, 2ml of glacial acetic acid and few drops of 5% ferric chloride were added. This was under layered with 1 ml of concentrated sulphuric acid. Formation of brown ring at the interface indicated the presence of cardiac glycosides.

3.3.2.9 Test for Terpenoids

(Keller-kilani test), To the extract of 0.5ml, 2ml of chloroform and concentrated sulphuric acid was added carefully. Formation of red brown colour at the interface indicated the presence of terpenoids.

3.3.2.10 Test for Phenols

To the extract of 1ml, 2ml of distilled water followed by few drops of 10% ferric chloride was added. Formation of blue or green colour indicated the presence of phenols

3.3.2.11 Test for Coumarins

To the extract of 1ml, 1ml of 10% sodium hydroxide was added. Formation of yellow colour indicated the presence of coumarins.

3.3.2.12 Test for Steroids and Phytosteroids

To 1ml of plant extract equal volume of chloroform was added and subjected with few drops of concentrated sulphuric acid. The appearance of brown ring indicated the presence of steroids and appearance of bluish brown ring indicate the presence of phytosteroids.

3.3.2.13 Test for Phlobatannins

To the plant extract 1ml, 2% hydrochloric acid was added. The appearance of red colour precipitate indicated the presence of phlobatannins.

3.3.2.14 Test for Anthraquinones

To the plant extract of 1ml, 10% of ammonia solution was added and appearance of pink colour precipitate indicated the presence of Anthraquinones.

3.3.4 Antibacterial Test

Agar diffusion Method

The growth method is performed as follows

- At least three to five well-isolated colonies of the same morphological type are selected from an agar plate culture. The top of each colony is touched with a loop, and the growth is transferred into a tube containing 4 to 5 ml of a suitable broth medium, such as Nutrient broth.
- The broth culture is incubated at 35°C until it achieves or exceeds the turbidity (usually 2 to 6 hours)
- The turbidity of the actively growing broth culture is adjusted with sterile saline or broth to obtain turbidity. This results in a suspension containing approximately 1 to 2 x 10⁸ CFU/ml for *E.coli* and *Staphylococcus aureus*.

Inoculation of Test Plates

- Optimally, within 15 minutes after adjusting the turbidity of the inoculum suspension, a sterile cotton swab is dipped into the adjusted suspension. The swab should be rotated several times and pressed firmly on the inside wall of the tube above the fluid level. This will remove excess inoculum from the swab.
- The dried surface of a Nutrient agar plate is inoculated by streaking the swab over the entire sterile agar surface. This procedure is repeated by streaking two more times, rotating the plate approximately 60°c each time to ensure an even distribution of inoculum. As a final step, the rim of the agar is swabbed.
- The lid may be left ajar for 3 to 5 minutes, but no more than 15 minutes, to allow for any excess surface moisture to be absorbed before applying the drug impregnated disks.
- The media was punctured by making a well of 6 mm in diameter and filled with 50 µl of a sample. Further the petriplates were placed inversely for complete diffusion and inhibition zones were examined by measuring the diameter (mm) formed around the well after 24 hrs incubation at 37°C. The zones were measured by using standard (Hi-Media) scale.

3.3.5 Toxicity

Preparation of Samples

The given extract sample is diluted with distilled water to get 1% stock solution. The samples (PH) of different volume 100, 250, 500, 1000, 1500 μ l are added to each beaker containing saline solution respectively and results from Bharat Rata prof.CNR Rao Rese.arch center, Avinashilingam University

Procedure

- 30 shrimps where, Introduced into the sample solution of various concentration.
- The movement of shrimp is monitored at intervals of 1, 2, 4, 6, 24 hours.
- Blank solution: 30 shrimps in Brine solution
- Positive control: Potassium dichromate (1mg/ml).
- The mortality of shrimp is calculated after 24 hours.
- For each of the sample, 30 shrimps were added to 25ml of the solution.
- The mortality of the shrimps was monitored as that of blank and positive control.

3.4 SELECTION OF APPLICATION METHOD ON FABRICS

Both cotton and poly cotton fabrics were finished using two different methods

3.4.1 Dip and Dry Method

The untreated fabric is dipped into the extraction solution for 24 hours.

3.4.2 Boiling method

The untreated fabric is heated into the extracted solution for 30mins

3.5 OPTIMIZATION PROCEDURE FOR MULTIFUNCTIONAL FINISHING

The optimization of standard condition for multifunctional finish done for the treated fabrics. Optimization for treatment was carried out for various parameters such as extract concentration, time and temperature after giving the finish to the fabric. The sample is taken out, dried and its activity evaluated.

3.5.1 Determination of optimum concentration for finish on fabric

The fabric was treated with two different concentration of *pelargonium hybridum* extract liquid.100% extraction for dip and dry method and boiling method.50%extraction and 50% distilled water for dip and dry method and boiling method. The material liquor ratio is 6:180.

3.5.2 Determination of optimum time for finish on fabric

The multifunctional finish of cotton and poly cotton fabrics treated with the extract of *pelargonium hybridum* was carried out at optimized concentration with constant temperature for constant time interval. For soaking method done for 24 hours and for boiling method 30 minutes.

3.5.3 Determination of optimum temperature for finish on fabric

For dip and dry method with two different concentration in room temperature. For boiling method with two different concentration in room temperature.

Table I

Optimization of parameter for finishing

PARAMETERS	LEVEL	LEVEL
Finishing methods	Dip and Dry method	Boiling method
Concentration	100%Extract and 50%extract	100%Extract and 50%extract
Time	24 hours	30mins
Temperature	Room temperature	Room temperature

3.6 COST ESTIMATION

The cost of cotton and poly cotton material, detergent used for desizing process was calculated

3.7 NOMENCLATURE

The nomenclature used for samples finished with various method is expressed in Table 1

Table II
Nomenclature of Samples

S.NO	FABRIC DETAIL	NOMENCLATURE
1	ORGANIC COTTON	OC
2	DIP AND DRY WITH 50% EXTRACT ON COTTON	DC1
3	DIP AND DRY WITH 100% EXTRACT ON COTTON	DC2
4	BOILING METHOD WITH 50% EXTRACT ON COTTON	BC1
5	BOILING METHOD WITH 100% EXTRACT ON COTTON	BC2
6	POLYESTER COTTON	PC
7	BOILING METHOD WITH 50% EXTRACT ON POLYCOTTON	BPC1
8	BOILING METHOD WITH 100% EXTRACT ON POLYCOTTON	BPC2

3.8 EVALUATION

The unfinished and finished samples were subjected to antimicrobial activity, toxicity test and 3D optical profiler. Subjective and objective evaluation was carried out for the finished fabric.

3.8.1 Objective Evaluation

For each fabric, standard ASTM test method were followed to measure fabric weight and thickness, tensile strength and elongation, stiffness, abrasion resistance and wettability and absorbency, colour fastness. (Mansdorf et al.,1988).

3.8.1.1 Fabric Weight

Fabric weight is measured as mass per unit area. Fabric mass per unit area is expressed either as grams per square meter (ounces per square yard), or grams per linear meter, ounces per liner yard fabric is also sometimes expressed inversely as linear meters per kilograms (yard per pound) with the fabric width stated, ASTM D3776 96 (2002).following the procedure all the samples are weighed using electronic balance (Plate-VIII).

3.8.1.2 Fabric Thickness

Fabric thickness is measured by a thickness gauge. The thickness value of most textile materials will vary considerably, depending on the pressure applied to the specimen at the time the thickness measurement is taken. In all cases, the apparent thickness varies considerably with the pressure applied. For this reason, it is essential that the pressure be specified when discussing or listing any thickness values state Mehta et al., (1998) (Plate-IX).The instrument used for testing fabric thickness is Hungarian Thickness Tester. This tester has two parts, the anvil and the pressure foot, which works under a lever spring action. On the top of this instrument there is a dial which indicate the thickness of the sample in the thousand of an inch. Each division on the dial read is 0.01mm. Each samples was placed on the anvil plate and the lever of the presser foot released very slowly and the presser foot pressed the samples. Five readings were taken from different places of the fabric samples.

The samples OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 was cut with GSM (Grams per Square Meter) die cutter which is 100 cm². The samples 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.

3.8.1.3 Tensile strength and elongation

It is a test in which a material is extended in one direction to determine one or more of its force- extension or stress-strain, characteristics; for example breaking force, elongation at break, ASTM [D 13.58] D4848. Tensile Strength Tester is used to evaluate the untreated and treated fabric. Samples OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 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 pounds and the elongation in inches as well as centimeters was noted as soon as the sample was broken (Plate-X). Five readings were taken and the mean strength and elongation is calculated to measure the strength loss or gain in the fabric before and after finishing.

3.8.1.4 Abrasion Resistance

The complete movement for an abrasion cycle is dependent on the action of the abrasion machine and the test method used. It may consist of one back- and-forth unidirectional movement or one circular movement or a combination of both, ASTM D3885-04.

Abrasion Resistance Tester was used to determine abrasion resistance of the samples. Five samples were cut using template. The samples holder with 200Gms weight was used for this test. The rotations were standardized to 10min. The samples were made to rub against the abrasive surface (Plate-XI). After 10 rotations the samples were removed and final weight of the samples was found out. Weightone mean weight loss was calculated. Loss due to abrasion was calculated. The test was repeated for eight samples OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 and one mean weight loss was calculated

3.8.1.5 Fabric Stiffness

Chiley stiffness tester is used to measure the bending stiffness of the fabric. The test specimen is 25mm wide and 200mm long. Three samples are cut in warp and weft direction but the threads should not be same. The specimens OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 should be cut using the template. The template and the specimen are placed in the horizontal plane. The scale is moved along with the fabric. The sample started to fell down to the platform and coincide with the index line. This should be viewed in the mirror (Plate-XII).The reading should be noted which is on the side of the platform. The same procedure is for both warp and weft direction. The readings should be noted and the mean value is calculated (Booth.1996).

3.8.1.6 Color Fastness to Rubbing(dry&wet)

Crock meter is used to asset the fastness of dyed fabric under the wet and dry condition during rubbing. The samples OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 of size 12 inches length and 4 inches width were cut from the samples. The white cotton material was cut and fixed at the end of the Crockmeter. The metal blocks should be rubbed by using handle for 20 times (Plate-XIII).

- **Wet Crocking:** The color fastness of a dyed fabric is asset by the transfer the color from the dyed fabric to another undyed fabric while the fabric is wet.
- **Dry Crocking:** The same procedure was followed but the fabric, which is kept under, must be dry. The color fastness can be measured using the AATCC grey scale (Tsatsaroni et al, 2016).

3.8.1.7 Sinking Test

This involves a simple test for wettability of fabric. In this test, a small square specimen 1 x 1 inch is cut and dropped into the surface of water in a beaker.The time taken for the specimen to sink below the surface is observed. The shorter the time, the greater the wettability (Raul, 2005). Sinkingis a simple test of wettability of fabrics (Plate XIV). In this test a sample measuring 5" x 5" was cut and dropped into the surface of water in a beaker. 1000ml beaker was filled with distilled water and added few drops of wetting agent into distilled water. The samples OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 was dropped on the surface of water from a standard height.

The stop watch was started when the fabric struck the surface of water and stopped when the last corner sank below the water surface and the time required for the sample to sink was noted. The same procedure was repeated for five samples. Then the mean value was calculated for the above samples. Similarly the mean value of the original and treated fabric material were calculated and the sinking time of each material was recorded separately.

3.8.1.8 Wicking Test

Liquid movement which is primarily perpendicular to the plane of the fabric is termed transplanar uptake or transplanar flow. Transplanar uptake is also referred to as "demand wettability". Liquid flow in a direction parallel to the plane of the fabric is termed planar uptake or planar flow and is also referred to as "wicking" (Johnson et al., 1996).

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 (XV). 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 fabrics OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 and recorded in centimeters.

3.8.1.9 Spray test

Spray test helps in measuring the water repellence of the fabric. For this test, 250ml of water are poured through a spray nozzle. The fabric sample is placed using an embroidery hoop and fixed at an angle of 45 degrees. The evaluation is based on chart of photographs to which the actual appearance of the sample is compared. It was recommended by the American Association of Textile Chemists and Colorists (Plate-XVI).

The specimens OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 were tested as directed by the standard AATCC TM22. (Quantifying Water Repellency by Modifying Spray Test Method AATCC TM22 to Extend Test Duration Allowing Discrimination between Similarly Graded Fabrics, Philippa J, Sage Journal)

Table III

Spray test rating

RATING	DESCRIPTION
100	No sticking or wetting of the upper surface
90	Slight random sticking or wetting of the upper surface
80	Wetting of upper surface at spray points
70	Partial wetting of whole of upper surface
50	Complete wetting of whole of upper surface
0	Complete wetting of whole of upper and lower surfaces

3.8.2 Ultra Violet Protecting Factor

UV Analyzer

Test Standards for UV Protective Textiles

AS/NZS 4399 (Australia /Newzealand), American Association of Textile Chemists and Colorists (AATCC) Test method 183 (USA), BS7914 (British Standards Institution, Great Britain) and European Standard EN13758-1 are the standard test methods presently in use. Differences among the test methods exist particularly with regard to scanning intervals, positioning of the textile in the instruments and the erythema action spectrum designated.

In July 1996 Australia became the first country to introduce a standard for evaluating and classify sun protective clothing (AS/NZS 4399:1996 'Sun Protective Clothing — Evaluation and Classification'). The standard uses the term ultraviolet protection factor (UPF) to designate the amount of protection provided by personal clothing.

Traditionally, the determination of the UPF of a fabric was analyzed by placing a template with various fabric samples next to human skin. Ultraviolet 94 radiation upto 60 times as strong as the sun's rays, was directed through the fabric and onto the skin for varying lengths of time. The resulting degree of sunburn to the exposed skin determined the fabric's protection factor. Unfortunately, this method exposes subjects to potentially unsafe levels of UV radiation.

The UV testing of textiles seems to be most difficult as far as reproducibility of test result is concerned. It is difficult to get same sun light conditions throughout the year worldwide. Many instruments have been developed but due to inconsistency in artificial UV emissions, the results have been misleading. However, recent use of Flash Xenon Lamp in UV Transmittance Analyzer has proved to be the best alternative for reproduction of natural sunlight Gaur et al. (2006).

Precaution while preparing the sample for testing

- At least four specimens need to be taken from each sample.
- Two specimens are to be tested in machine direction and other two in cross machine direction.
- Specimen size should be at least 2X2 inch.
- Each colour area should be tested, in case garment has areas of different colours and lower colour rating need to be reported.
- The area with the lowest cover factor (that is most open structural area) should be used as sample, in case garment has different textures.
- The lining and outer fabric should be tested together, in case of lined garment.
- Specimen size should be sufficient to cover the sample aperture of the available spectrophotometer.
- Specimen fabric structure should not get distorted while preparing the sample.

The instrument software automatically calculated the average value of UVA, UVB transmittance and Ultraviolet Protection Factor (UPF) of the sample. Fabric samples OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 can be graded as per UPF Classification System given in Table IV (Plate-XVII).

Table IV

UPF Classification system

UPF range	UVR protecting category	Effective UVR transmission %	UPF rating
15-24	Good protection	6.7-4.2	15,20
25-29	Very good protection	4.1-2.6	25,30,35
40-50,50+	Excellent protection	2.5	40,45,50,50+

3.8.3 Mosquito Repellent

Methodology of Mosquito Repellent:

Hay infusion method was adopted for culturing mosquito larvae. Hay was taken, cut into small pieces and boiled in 5 liters of water was poured into buckets and kept in different areas where mosquitoes were abundant (Plate-IV).

After one or two days eggs were laid by female mosquitoes in clusters forming an egg raft. The egg rafts were collected and maintained in the laboratory. The third instar larvae were collected, reared in enamel trays containing culture medium and provided with powdered dog biscuits and yeast in the ratio of 3:1 as the nutrient source. Immediately after moulting the fourth instar larvae were introduced into mosquito cage.

CAGE -1

PHASE – 1

Third and fourth instar larva of mosquito were introduced into mosquito cage on 22.2.2023 at 12:30 pm. Larval movement were observed and the fabric were not introduced inside the cage. The larval were more active.

PHASE – 2

The *Pelargonium hybridum* leaf are extracted by aqueous method. These extract at different concentration namely 50% and 100% were treated on cotton and poly cotton fabric. Fabrics have been given finish using soaking and boiling method using the aqueous extract. So including untreated fabric totally 6 samples have been introduced to the mosquito cage on 23.02.2023 at 12:30 pm. The larval activity where observed after keeping fabric inside the mosquito cage. Slowly larval activity were decreased due to active compound present in the leaf extract.

PHASE – 3

After 24hrs on 24.02.2023 at 12:30 some larva developed to pupal stage and many larva was dead due to compound present in the *Pelargonium hybridum*. The larval and pupal activity were slow.

PHASE – 4

Pupal activity and larval activity were similar to that of previous day on 25.02.2023.

PHASE – 5

Few adults were developed from the pupa (5). But these were not attracted by the fabric due to presence of active compound found in the *pelargonium hybridum*.

PHASE – 6

Few adults were found dead on 27.02.2023. The fabric were removed from cage and the mosquito and larval were discarded safely.

CAGE – 2

PHASE – 1

The mosquito larval has introduced into the cage on 24.02.2023 at 12:30 pm. The larval were feed food by 2:30pm. The fabrics were not introduced into the cage. The activity of larval was good.

PHASE – 2

The larval was developed to pupa stage on 25.02.2023 at 12:30pm (after 24 hrs) the activity of larval and pupa were good active. The fabric where not introduced to cage at this stage.

PHASE – 3

Few adults have been developed and pupa and larval were good active. The food have been feed by 26.02.2023 at 10:30am.

PHASE – 4

The *pelargonium hybridum* leaf has extracted by aqueous method. These extract at different concentration namely 50% and 100% were treated on cotton and poly cotton fabric. Fabrics have been given finish using soaking method and boiling method. So including untreated fabric totally 6 samples have been introduced to the mosquito cage on 27.02.2023 at 12:30 pm. The adult activity was started to get down during day time. The other larval and pupal activity was also started getting slow down.

PHASE – 5

After 24hrs on 28.02.2023 the activity of adults, pupal, larva decreased simultaneously, due to the attraction of extract. Few adults were dead due to extract finishes.

PHASE – 6

Few adults around 3 were dead, pupal and larval growth of few get slowed and some pupal and larval activity decreased completely.

PHASE – 7

All the adults mosquito were dead. Some pupal and larval were also dead. Other larval activity got decreased completely due to the extract finish on the fabric. On 02.03.2023 at 12:30pm the fabrics were removed. Pupal and larval were discarded safely.



PLATE-I

Collected the *pelargonium hybridum* leaf in horticultural research station -Udhagamandalam



PLATE-I

Collecting leaves



PLATE-II

Leaf with flower

PLATE-I COLLECTION OF *PELARGONIUM HYBRIDUM* LEAF



PLATE -II



PLATE-II



PLATE-II

PLATE-II PROCESSING OF PELARGONUM LEAF EXTRACT



PLATE-II



PLATE-II



PLATE-II

PLATE-II PROCESSING OF *PELARGONUM LEAF* EXTRACT



PLATE-III



PLATE-III



PLATE-III

PLATE-III *PELARGONIUM LEAF* FINISHES BY BOILING METHOD



PLATE-III



PLATE -III

PLATE-III *PELARGONIUM LEAF* FINISHES BY BOILING METHOD



PLATE-IV

Eggs laid by female Mosquitoes



PLATE-IV

Collection of larva



PLATE-IV

Larva placed in the tray

PLATE -IV MOSQUITO REPELLENCY STUDY



PLATE-IV

Cage Set up



PLATE-IV

Treated fabric in Mosquito cage

PLATE-IV MOSQUITO REPELLENCY STUDY

Result and discussion

4. RESULTS AND DISCUSSION

The results of the study on “**Assessing multifunctional Efficiency on Cotton and Polyester Cotton fabrics with *Pelargonium hybridum* leaf extract**” is discussed under the following headings.

4.1 Characterization of Herbal Test

4.1.1 Phytochemical test

4.1.2 Toxicity test

4.2 Anti bacterial

4.2.1 Antibacterial test

4.3 Objective Evaluation

4.3.1 Fabric weight

4.3.2 Fabric thickness

4.3.3 Fabric strength-warp

4.3.4 Fabric strength-weft

4.3.5 Fabric elongation-warp

4.3.6 Fabric elongation-weft

4.3.7 Fabric abrasion

4.3.8 Fabric stiffness-warp

4.3.9 Fabric stiffness-weft

4.3.10 Fabric colourfastness

4.3.11 Roughness test

4.4 Wettability and Absorbency Test

4.4.1 Sinking test

4.4.2 Wickability test

4.4.3 Spray test

4.5 Ultraviolet Protecting Factor

4.5.1 UPF test on samples

4.6 Mosquito Repellency

4.6.1 Mosquito repellency test

4.1 Characterization of Herbal Test

4.1.1 Phytochemical test

Table V
Phytochemical screening

S.NO	Metabolite	Test performed	Observation	Result
1.	Alkaloids	+ Mayer's reagent	Presence of cream coloured precipitate	+
2.	Flavonoids	Alkaline test	Intense yellow colour turning colourless on addition of dil.HCl	+
3.	Sterols (Liebermann test)	+ CHCl ₃ + Acetic Anhydride +Conc.H ₂ SO ₄	Presence of reddish brown ring	+
5.	Anthraquinone (Borntrager's test)	+ FeCl ₃ + Conc. HCl + diethyl ether + Ammonia	Presence of reddishorange colour	+
6	protein	+ conc. HNO ₃	Presence of Yellow colouration	+
7	Carbohydrates	Molisch's test	Presence of Violet ring	+
		Fehling's test	Presence of Red precipitate	+
9	Tannin	Braymer's test	Presence of bluish green colour	+
		+ Gelatin test	Presence of white precipitate	+
		10% NaOH test	Presence of emulsion	+
10	Cardiac glycosides	+ Baljet reagent	Presence of yellow orange colour	+
		Keller-killani test	Keller-killani test	+

From the Table V it is clear that the extraction of leaf contains Alkaloids, flavonoids, Sterols, Anthraquinone, Proteins, Carbohydrates, Tannin, Cardiac glycosides were detected in aqueous extraction from method of leaf .The Phytochemical test of *pelarzonium hybridum* can be made available commercially for its medicinal value. While phytochemical compounds such as tannin coagulate the wall proteins, facilitated the entry of toxic material or leakage of vital constituents from the cell . Flavonoids inhibit the activity of enzymes by forming complexes with bacterial cell walls, extracellular and soluble proteins, more lipophilic flavonoids disrupt cell wall integrity or microbial membranes at low concentrations.

4.1.2 Toxicity Test

Table VI
Toxicity test

S. No	Sample Code	Concentration (µg/ml)	Mortality of Brine shrimp (no. of shrimps dead) (h)					
			1	2	4	6	24	% Mortality (at 24h)
1.	Extract	100	0	0	0	1	1	3
		250	0	0	0	1	3	10
		500	0	0	1	2	2	7
		1000	0	0	1	1	2	7
		1500	0	0	0	1	3	10
2.	Control K2Cr2O7	1 (mg/ml)	30	-	-	-	-	100
3.	Blank	Saline water	0	0	0	0	0	0

N= 30.

The sample is comparatively not toxic than $K_2Cr_2O_7$ which shows maximum lethality of shrimps at higher concentration. The shrimps in the sample are found to be non-toxic in lower concentration as well as in higher concentration. Even after 24h, only three shrimps are found to be mortal at highest concentration.

4.2 Anti bacterial

4.2.1 Antibacterial Test

Table VII

Anti bacterial

Sample	Zone of Inhibition (mm)	
	<i>Staphylococcus aureus</i>	<i>E.coli</i>
Standard (Rifampicin)	35mm	17mm
Negative control (Water)	0mm	0mm
PH	16mm	15mm

From the Table VII, it is evident that *Pelargonium hybridum* leaf extract shows Anti bacterial Activity against both Extract of leaf is treated with two different bacteria namely *Staphylococcus aureus* and *E.coli*. It is observe that Anti bacterial activity against E.coli is on par with the commercial statement. Existence of Anti bacterial activity due to the presence of alkaloids .

4.3 OBJECTIVE EVALUATION

4.3.1 Fabric Weight

The fabric weight of the OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 is presented in the Table VIII and Figure I

Table VIII

Weight of original samples and treated samples

SAMPLE	MEAN WEIGHT(gm/sq. mt)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	105	-	-	3.07	0.034*
DC1	109	0.04	3		
DC2	111	0.06	5		
BC1	121	0.16	13		
BC2	124	0.19	15		
PC	62	-	-	7.99	0.004*
BPC1	87	0.25	20		
BPC2	105	0.43	35		

*-Significant at 5% level ($p < 0.05$)

From the Table VIII it is clear that the fabric weight of the original samples OC and PC was 105GSM and 62 GSM. Fabric weight of the treated samples DC1,DC2,BC1,BC2,PC,BPC1,BPC2 is measured as 109,111,121,124,87,105 GSM respectively. Hence it could be concluded that the weight increased after the treatment with *pelargonium hybridum* extract.

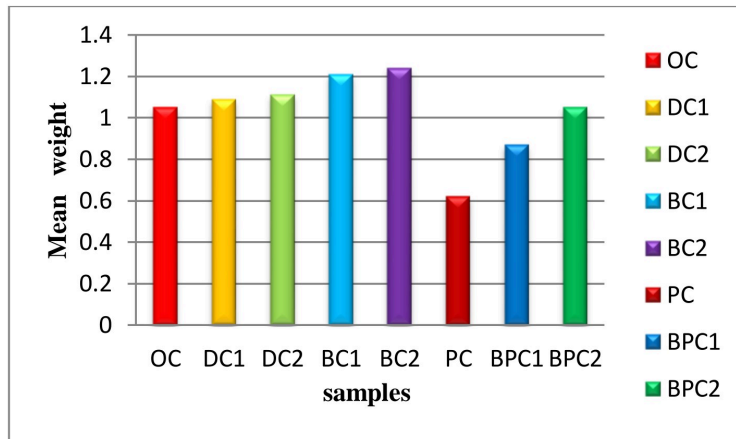


FIGURE- I FABRIC WEIGHT

4.3.2 Fabric thickness

The fabric thickness of the OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 is presented in the Table IX and Figure II

Table IX

Thickness of original samples and treated samples

SAMPLE	MEAN THICKNESS(mm)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	0.40	-	-	4.12	0.011*
DC1	0.42	0.02	4		
DC2	0.44	0.04	8		
BC1	0.50	0.1	20		

BC2	0.51	0.11	22		
PC	0.29	-	-	6.62	0.009*
BPC1	0.37	0.08	73		
BPC2	0.38	0.09	18		

*-Significant at 5% level ($p < 0.05$)

From the Table IX it is clear that the fabric thickness of the sample OC and PC was 0.40 mm and 0.29 mm. Fabric thickness of the sample DC1, DC2, BC1, BC2, BPC1, BPC2 is measured as 0.42 mm, 0.44 mm, 0.50 mm, 0.51 mm, 0.37 mm, 0.38 mm respectively. Hence it could be concluded that after treatment the thickness of the fabric increased gradually in all samples

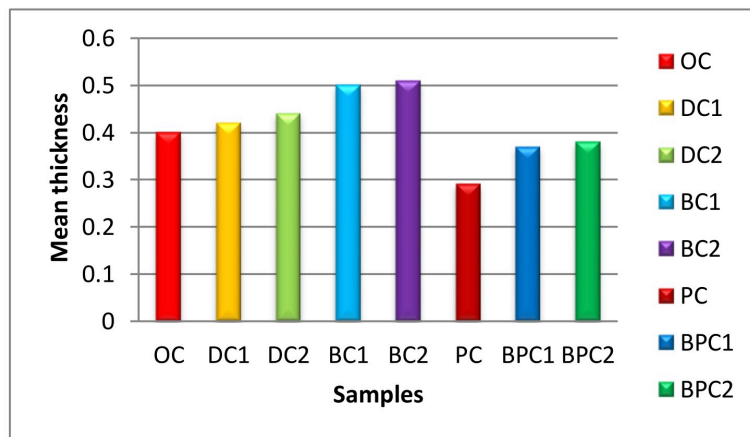


FIGURE II-FABRIC THICKNESS

4.3.3 FABRIC STRENGTH- WARP

The tensile strength of OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 among warp direction is presented in the Table X and Figure III

Table X

Fabric strength-warp of original samples and treated samples

SAMPLE	MEAN STRENGTH (Kg)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	34	-	-	6.28	0.001*
DC1	36	2	4		
DC2	36	2	4		
BC1	37	3	6		
BC2	41	7	13		
PC	47	-	-	4.07	0.039*
BPC1	50	3	6		
BPC2	52	5	10		

*-Significant at 5% level ($p < 0.05$)

From the Table X it is obvious that the treated all samples increased among warp direction. strength of OC and PC samples among warp direction is noted to be (34kg) and (47 kg) among the tensile strength of DC1,DC2,BC1,BC2 is 36 kg,36 kg,37 kg,41 kg,50 kg ,52 kg respectively. Hence it could be concluded that strength in warp direction gradually increased in all samples

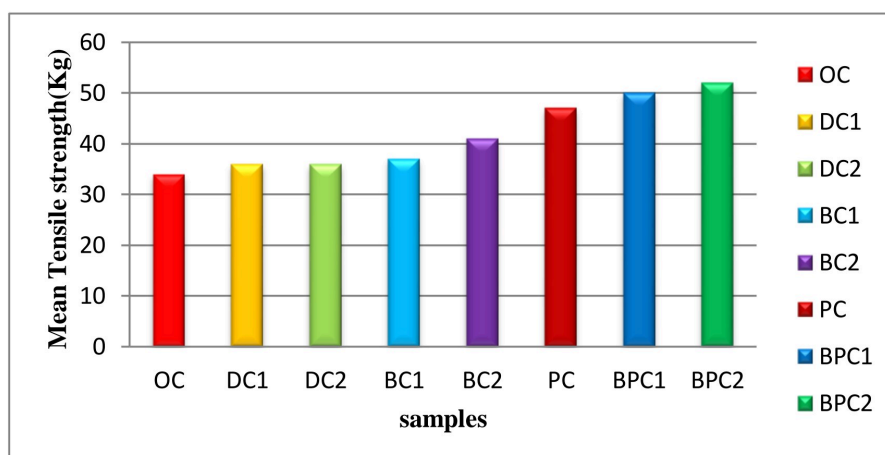


FIGURE- III FABRIC STRENGTH-WARP

4.3.4 FABRIC STRENGTH-WEFT

The tensile strength of OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 in weft direction is presented in the Table XI and figure VI

Table XI

Fabric strength-weft of original samples and treated samples

SAMPLE	MEAN STRENGTH(kg)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	36	-	-	3.03	0.036*
DC1	39	3	5		
DC2	42	6	9		
BC1	45	9	14		

BC2	50	14	21		
PC	44	-	-	6.34	0.010*
BPC1	62	18	27		
BPC2	66	22	33		

*-Significant at 5% level ($p < 0.05$)

From the Table XI it is obvious that the treated all samples increased among weft direction. Strength of OC and PC samples in weft direction is noted to be (36 kg) and (44 kg) among the tensile strength of DC1,DC2,BC1,BC2,BPC1,BPC2 is 39 kg,42 kg,45 kg,50 kg,62 kg, 66 kg increased in all samples. Hence it could be concluded that strength in weft direction increased irrespective of the types of finishing treatment.

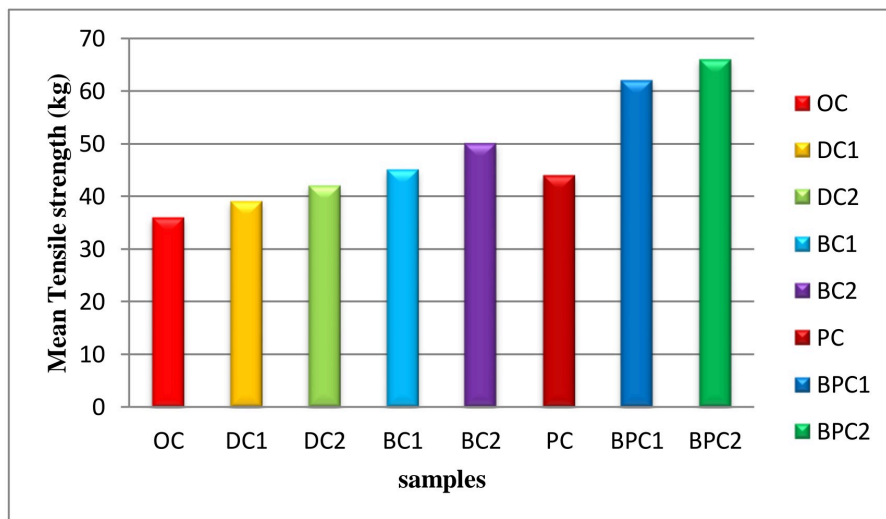


FIGURE –IV FABRIC STRENGTH-WEFT

4.3.5 FABRIC ELONGATION-WARP

The elongation of OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 among warp direction is presented in the Table XII

Table XII

Fabric elongation–warp of original samples and treated samples

SAMPLE	MEAN ELONGATION (cm)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	3.3	-	-	4.50	0.007*
DC1	3.3	0	0		
DC2	3.4	0.1	3		
BC1	3.6	0.3	8		
BC2	3.7	0.4	11		
PC	3.2	-	-	4.75	0.025*
BPC1	3.5	0.3	8		
BPC2	3.6	0.4	11		

*-Significant at 5% level ($p < 0.05$)

From the Table XII it is obvious that the treated all samples increased among warp direction. Elongation of OC and PC samples in warp direction is noted to be (3.3 cm) and (3.2 cm) among the elongation of DC1,DC2,BC1,BC2,BPC1,BPC2 is 3.3 cm,3.4 cm,3.6 cm,3.7 cm increased in all samples. Hence it could be concluded that elongation in warp direction increased irrespective of the types of finishing treatment.

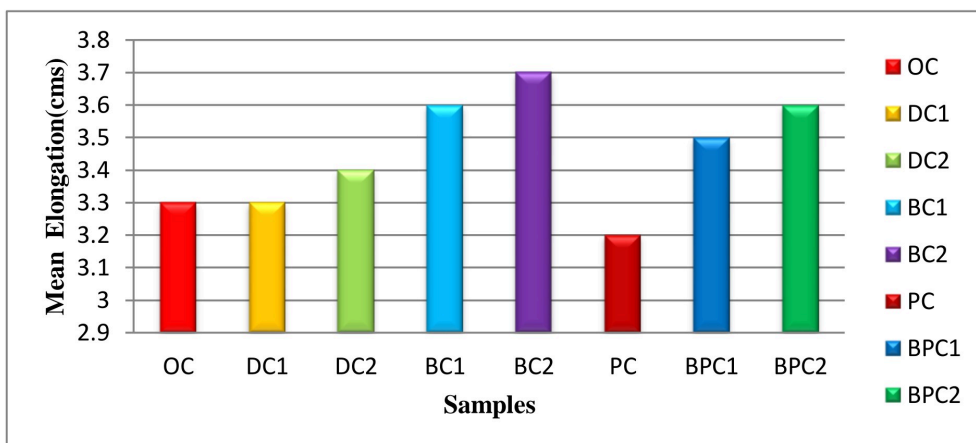


FIGURE - V FABRIC ELONGATION-WARP

4.3.6 FABRIC ELONGATION-WEFT

The elongation of OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 in weft direction is presented in the Table XIII and figure VI

Table XIII

Fabric elongation –weft of original samples and treated samples

SAMPLE	MEAN ELONGATION (cm)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	4	-	-	5.79	0.002*
DC1	4.2	0.2	4		
DC2	4.2	0.2	4		
BC1	4.3	0.3	6		
BC2	4.4	0.4	8		

PC	3	-	-	8.18	0.004*
BPC1	4	1	20		
BPC2	5	2	40		

*-Significant at 5% level ($p < 0.05$)

From the Table XIII it is clear that the treated all samples increased in weft direction. Elongation of OC and PC samples in weft direction is noted to be (4 cm) and (3cm) among the tensile strength of DC1,DC2,BC1,BC2,BPC1,BPC2 is 4.2 cm, 4.2 cm,4.3 cm,4.4 cm 4 cm,5 cm increased in all samples.

Hence it could be concluded that elongation in weft direction increased irrespective of the types of finishing treatment.

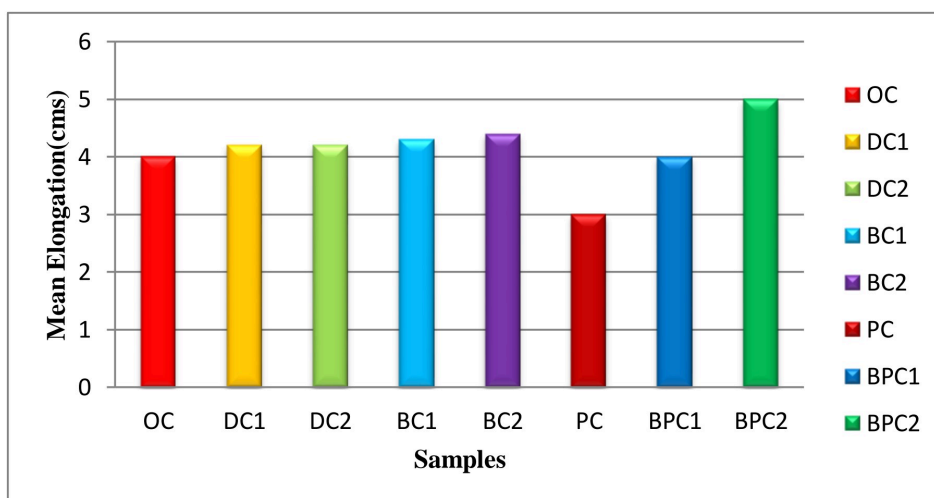


FIGURE -VI FABRIC ELONGATION-WEFT

4.3.7 FABRIC ABRASION

The evaluation results of the abrasion resistance test of OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 is presented in the Table XIV

Table XIV
Abrasion resistance of original samples and treated samples

SAMPLE	MEAN RESISTANCE in (gms)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	11	-	-	5.69	0.002*
DC1	6	5	45		
DC2	6	5	45		
BC1	7	4	36		
BC2	8	3	27		
PC	10	-	-	10.31	0.002*
BPC1	7	3	27		
BPC2	7	3	27		

*-Significant at 5% level ($p < 0.05$)

From the Table XIV it is evident that the abrasion resistance of original sample of OC and PC is noted as 11gm and 10gm abrasion resistance of the treated samples 6gm,6gm,7gm,8gm,7gm,7 gm is measured as it is understood that the treated sample is lowered and reduced against original samples.

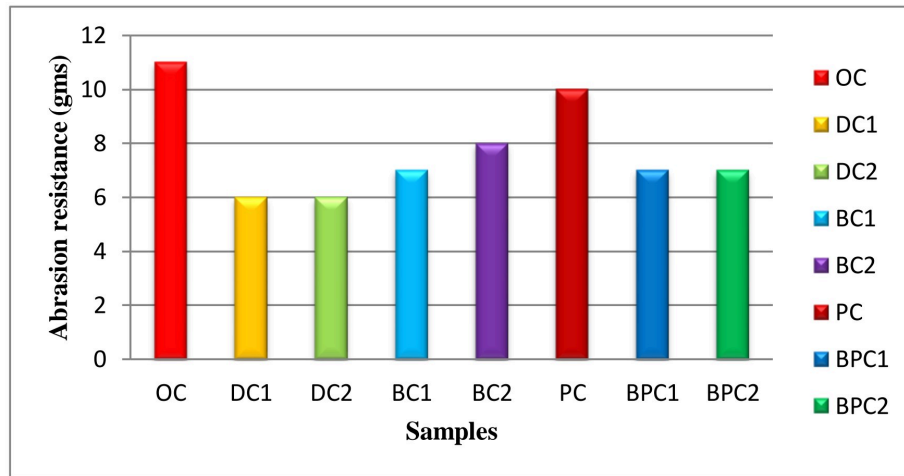


FIGURE –VII FABRIC ABRASION

4.3.8 FABRIC STIFFNESS-WARP

The evaluation results of the fabric stiffness test of warp in OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 is presented in the Table XV

Table XV

Fabric stiffness-warp of original samples and treated samples

SAMPLE	MEAN (cm)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	2.3	-	-	3.49	0.021*
DC1	2.5	0.2	6		
DC2	2.6	0.3	9		
BC1	3.2	0.9	26		

BC2	3.5	1.3	37		
PC	3.1	-	-	4.00	0.041*
BPC1	3.3	0.2	6		
BPC2	3.3	0.2	6		

*-Significant at 5% level ($p < 0.05$)

From the Table XV it is obvious that the elongation of OC and PC samples in weft direction is noted to be (2.3 cm) and (3.1 m) among the tensile strength of DC1,DC2,BC1,BC2,BPC1,BPC2 is 2.5cm, 2.6 cm, 3.2 cm,3.5 cm 3.3 cm, 3.3 cm increased in all samples. Hence it could be concluded that fabric stiffness in warp direction increased irrespective of the types of finishing treatment

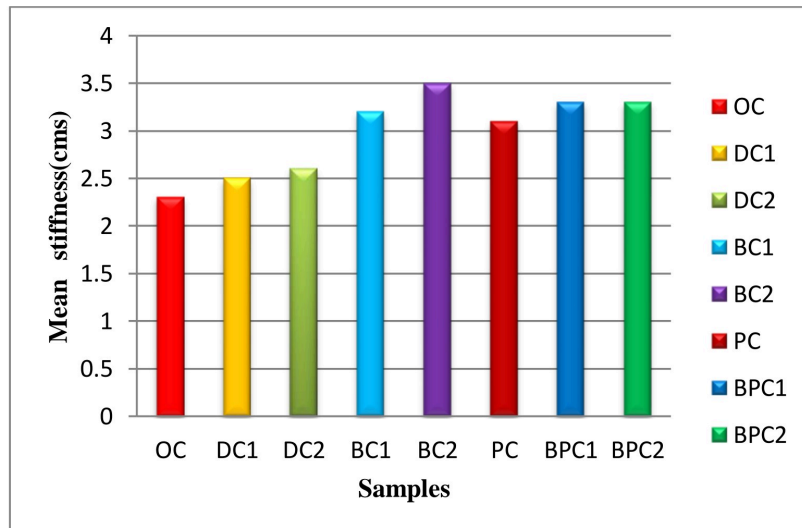


FIGURE-VIII FABRIC STIFFNESS –WARP

.3.9 FABRIC STIFFNESS-WEFT

The evaluation results of the fabric stiffness test of weft in OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 is presented in the Table XV I

Table XVI

Fabric stiffness –weft of original samples and treated samples

SAMPLE	MEAN (cm)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	2.5	-	-	2.89	0.043*
DC1	2.6	0.1	3		
DC2	2.6	0.1	3		
BC1	2.8	0.3	10		
BC2	2.9	0.4	14		
PC	3.5	-	-	4.60	0.028*
BPC1	3.4	0.1	3		
BPC2	3.4	0.1	3		

*-Significant at 5% level ($p < 0.05$)

From the Table XV it is obvious that the elongation of OC and PC samples in weft direction is noted to be (2.5 cm) and (3.5cm) among the tensile strength of DC1,DC2,BC1,BC2,BPC1,BPC2 is 2.6cm, 2.6 cm, 2.8cm, 2.9cm ,3.4cm, 3.4cm increased in all samples. Hence it could be concluded that fabric stiffness in weft direction increased irrespective of the types of finishing treatment

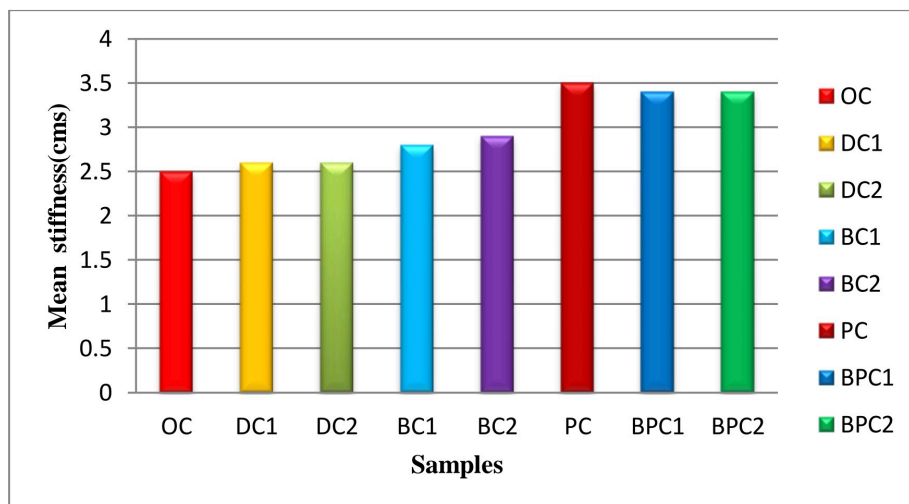


FIGURE-XI FABRIC STIFFNESS –WEFT

4.3.8 FABRIC COLOUR FASTNESS

The fabric colour fastness of the OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 results are presented in the Table XVII

Table XVII

Fabric colour fastness of original samples and treated samples

S.No	Samples	Crocking wet	Crocking dry
1	OC	5	5
2	DC1	4	4/5
3	DC2	3/4	3/4
4	BC1	3/4	3/4
5	BC2	4/5	4/5

6	PC	5	5
7	BPC1	3/4	¾
8	BPC2	4/5	4/5

Grading in grey scale: 5- Excellent 4- very good 3- good 2- fair 1- poor

From the Table XVII it is clear that color fastness to both wet and dry crocking shows an 5,4/5 result to all treated samples. Hence it is concluded that all treated samples has an good colour fastness

4.3.11 ROUGHNESS TEST

The parameters and the meaning of the roughness test in given in the Table XVIII

TABLE-XVIII

PARAMETER	MEANING
Ra	Arithmetic average of deviations from the mean
Rq	Root mean squared value of deviations
Rpv	Maximum peak to valley difference
Rp	Maximum peak height
Rv	Maximum valley depth
Rz	Average of (Rp-Rv) from five sections
Rsk	Skewness (asymmetry of distribution)

TABLE -XIX
ROUGHNESS TEST – SAMPLE OC

S.No	Sample OC	Ra	Rq	Rpv	Rp	Rv	Rsk	Rz	Rku
1.		19.44	25.69	128.21	48.34	79.88	-0.5045	76.04	3.881
2.		20.38	24.89	118.82	71.03	47.79	0.8540	73.02	3.375
3.		32.67	47.71	322.39	236.76	85.63	2.015	148.74	8.919
4.	Min	19.44	24.89	118.82	48.34	47.79	-0.5045	73.02	3.375
5.	Max	32.67	47.77	322.39	236.76	85.63	2.015	148.74	8.919
6.	Mean	24.17	32.77	189.81	118.71	71.10	0.7882	99.27	5.392
7.	SD	6.027	10.57	93.83	83.99	16.65	1.030	35.00	2.503
8.	Var%	24.9%	32.3%	49.4%	70.8%	23.4%	130.6%	35.3%	46.4%

From the Table XIX it is clear that in sample OC maximum peak Rp was 236.76 and the minimum Rp was 48.34. The value Rv ranged between 47.79 to 85.63 in sample OC. The mean Rp was 118.71 μ_m and Rv was 71.10 μ_m in sample OC.

TABLE-XX
ROUGHNESS TEST- SAMPLE BC1

S.No	Sample BC1	Ra	Rq	Rpv	Rp	Rv	Rsk	Rz	Rku
1.		14.37	18.44	108.29	72.60	35.69	0.5705	53.77	4.404
2.		15.00	19.05	89.31	47.23	42.07	-0.1507	44.52	3.006
3.		12.38	15.46	78.26	40.89	37.36	0.3011	52.17	2.851
4.	Min	12.38	15.46	78.26	40.89	35.69	-0.1507	44.52	2.851
5.	Max	15.00	19.05	108.29	72.60	42.07	0.5705	53.77	4.404
6.	Mean	13.92	17.65	91.95	53.57	38.38	0.2403	50.15	3.420

7.	SD	1.117	1.568	12.40	13.70	2.703	0.2975	4.039	0.6986
8.	Var%	8.03%	8.88%	13.5%	25.6%	7.04%	123.8%	8.05%	20.4%

From the Table XX it is clear that in sample BC1 maximum peak Rp was 72.60 and the minimum Rp was 40.89. The value Rv ranged between 42.07 to 35.69 in sample BC1. The mean Rp was 53.57 μ_m and Rv was 38.38 μ_m in sample BC1

TABLE-XXI

ROUHNESS TEST – SAMPLE BC2

S.No	Sample BC2	Ra	Rq	Rpv	Rp	Rv	Rsk	Rz	Rku
1.		20.24	27.63	187.49	106.61	80.88	0.2426	128.54	3.813
2.		21.92	29.27	138.33	98.33	40.00	1.538	62.12	5.651
3.		25.89	34.73	164.48	95.03	69.45	1.067	84.63	3.717
4.	Min	20.24	27.63	138.33	95.03	40.00	0.2426	62.12	3.717
5.	Max	25.89	34.73	187.49	106.61	80.88	1.538	128.54	5.651
6.	Mean	22.68	30.54	163.43	99.99	63.44	0.9493	91.76	4.394
7.	SD	2.368	3.034	20.08	4.870	17.22	0.5354	27.58	0.8900
8.	Var%	10.4%	9.93%	12.3%	4.87%	27.1%	56.4%	30.1%	20.3%

From the Table XXI it is clear that in sample BC2 maximum peak Rp was 106.61 and the minimum Rp was 95.03. The value Rv ranged between 80.88 to 40.00 in sample BC2. The mean Rp was 99.99 μ_m and Rv was 63.44 μ_m in sample BC2

TABLE-XXII**ROUGHNESS TEST – SAMPLE PC**

S.No	Sample PC	Ra	Rq	Rpv	Rp	Rv	Rsk	Rz	Rku
1.		36.52	49.58	290.34	174.62	115.72	1.037	131.60	5.226
2.		46.71	59.02	310.22	163.39	146.83	0.5017	136.04	3.148
3.		44.71	53.18	228.99	116.47	112.51	0.4002	152.58	2.063
4.	Min	36.52	49.58	228.99	116.47	112.51	0.4002	131.60	2.063
5.	Max	46.71	59.02	310.22	174.62	146.83	1.037	152.58	5.226
6.	Mean	42.65	53.92	276.51	151.49	125.02	0.6463	140.07	3.479
7.	SD	4.406	3.891	34.57	25.18	15.48	0.2794	9.030	1.312
8.	Var%	10.3%	7.21%	12.5%	16.6%	12.4%	43.2%	6.45%	37.7%

From the Table XXII it is clear that in sample PC maximum peak Rp was 174.62 and the minimum Rp was 116.47. The value Rv ranged between 146.83 to 112.51 in sample PC. The mean Rp was 151.49 μ_m and Rv was 125.02 μ_{min} in sample PC.

TABLE-XXIII**ROUGHNESS SAMPLE – TEST BPC1**

S.No	Sample BPC1	Ra	Rq	Rpv	Rp	Rv	Rsk	Rz	Rku
1.		18.52	24.32	106.85	45.12	61.73	-0.3727	58.16	3.126
2.		16.18	22.03	105.94	51.71	54.24	0.3546	65.50	3.217
3.		16.06	21.44	105.71	50.17	55.53	0.2095	61.50	3.220
4.	Min	16.06	21.44	105.71	45.12	54.24	-0.3727	58.16	3.126
5.	Max	18.52	24.32	106.85	51.71	61.73	0.3546	65.50	3.220
6.	Mean	16.92	22.60	106.17	49.00	57.17	0.0638	61.72	3.188

7.	SD	1.130	1.243	0.4917	2.817	3.271	0.3143	2.999	0.0435
8.	Var%	6.68%	5.50%	0.463%	5.75%	5.72%	492.9%	4.86%	1.37%

From the Table XXIII it is clear that in sample BPC1 maximum peak Rp was 51.71 and the minimum Rp was 45.12. The value Rv ranged between 61.73 to 54.24 in sample BPC1. The mean Rp was 49.00 μ_m and Rv was 57.17 μ_m in sample BPC1.

TABLE – XXIV
ROUGHNESS SAMPLE – TEST BPC2

S.No	Sample BPC2	Ra	Rq	Rpv	Rp	Rv	Rsk	Rz	Rku
1.		27.65	33.32	132.3	79.90	52.42	0.6441	49.55	2.428
2.		18.50	22.85	108.03	61.31	46.73	0.1277	67.52	2.770
3.		15.68	20.25	112.12	68.87	43.25	0.4931	66.64	3.555
4.	Min	15.68	20.25	108.03	61.31	43.25	0.1277	49.56	2.420
5.	Max	27.65	33.32	132.3	79.90	52.42	0.6441	67.52	3.555
6.	Mean	20.61	25.47	117.49	70.03	47.47	0.4217	61.24	2.920
7.	SD	5.100	5.648	10.62	7.637	3.783	0.2168	8.267	0.4707
8.	Var%	24.8%	22.2%	9.04%	10.9%	7.97%	51.4%	13.5%	16.1%

From the Table XXIV it is clear that in sample BPC2 maximum peak Rp was 79.90 and the minimum Rp was 61.31. The value Rv ranged between 52.42 to 43.25 in sample BPC2. The mean Rp was 70.03 μ_m and Rv was 47.47 μ_m in sample BPC2.

Comparison between the samples for Rp and Rv

TABLE XXV
Mean of Rp and Rv (μ_m)

S.No	Sample	Rp	Rv
1	OC	118.71	71.10
2	BC1	53.57	38.38
3	BC2	99.99	63.44
4	PC	151.49	125.02
5	BPC1	49.00	57.17
6	BPC2	70.03	47.47

From the Table XXV and figure it is clear that the sample PC exhibits the highest Rp value of 151.49. The sample PC exhibits the highest Rv value of 125.02. Hence it could be concluded that treated samples decreased compared to original samples due to the softness present in treated samples.

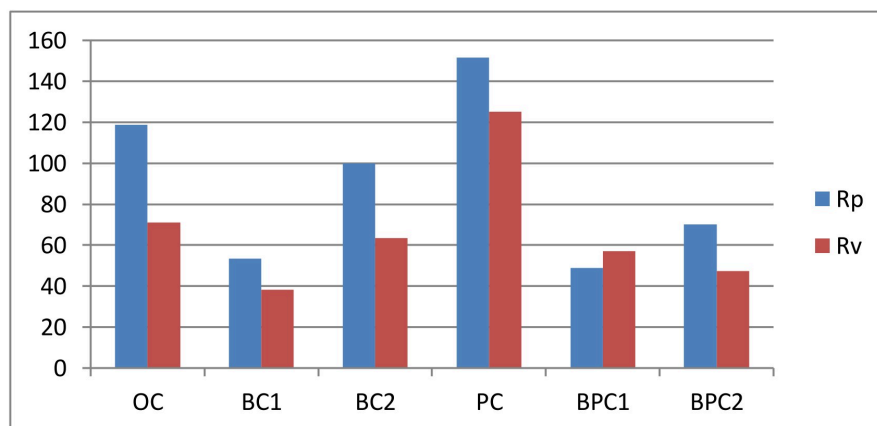


FIGURE-X FABRIC ROUGHNESS

4.4 WETTABILITY AND ABSORBENCY TEST

The result of the absorbency test carried out for the untreated and treated fabric in both warp and weft direction.

4.4.1 SINKING TEST

The result of sinking of OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 is presented in the Table XXVI AND Figure XI.

Table XXVI

Fabric sinking of original samples and treated samples

SAMPLE	MEAN (sec)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	6.2	-	-	4.02	0.012*
DC1	7.2	1	7		
DC2	7.4	1.2	8		
BC1	6.9	0.7	5		
BC2	7.5	1.3	9		
PC	9.3	-	-	5.11	0.020*
BPC1	12.4	3.1	20		
BPC2	15.2	5.9	39		

*-Significant at 5% level ($p < 0.05$)

From the Table XXVI it is clear that the sinking property was the maximum in BPC2 that is 15.2 sec. Hence it could be concluded that the absorbency rate increased in all sample

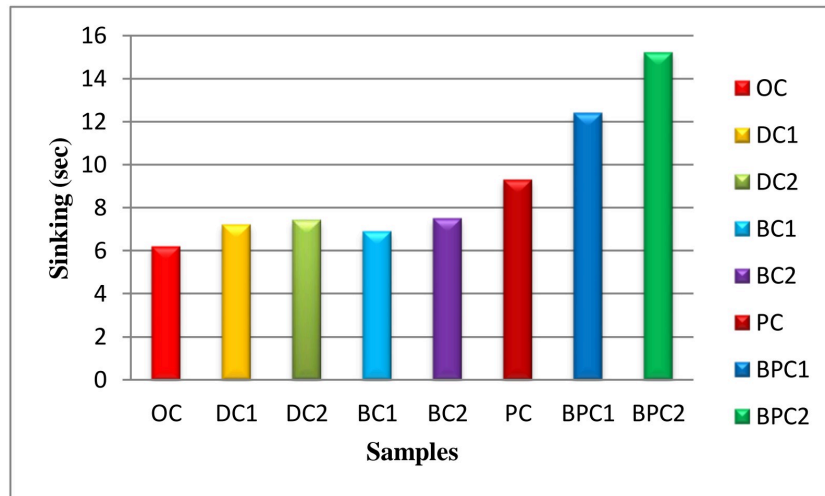


FIGURE-XI FABRIC SINKING

4.4.2 WICKING TEST

The result of the mean wicking time of original and treated samples along warp and weft

4.4.2.1 WICKING IN WARP

The result of wicking of OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 in warp direction is presented in the Table XXVII and Figure XII

Table XXVII

Fabric wicking in warp of original samples and treated samples

SAMPLE	MEAN (cm)	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	4.45	-	-	2.97	0.039*
DC1	5.62	1.17	20		
DC2	5.88	1.43	24		

BC1	5.55	1.1	19		
BC2	5.74	1.29	22		
PC	2.24	-	-	4.57	0.028*
BPC1	3.26	1.02	17		
BPC2	3.46	1.22	21		

*-Significant at 5% level ($p < 0.05$)

From the Table XXVII is observed that the mean wicking of original sample is 4.45cm and 2.24 cm .it has increased in treated samples. Hence it could be concluded that the wicking absorbency rate increased in treated samples of warp

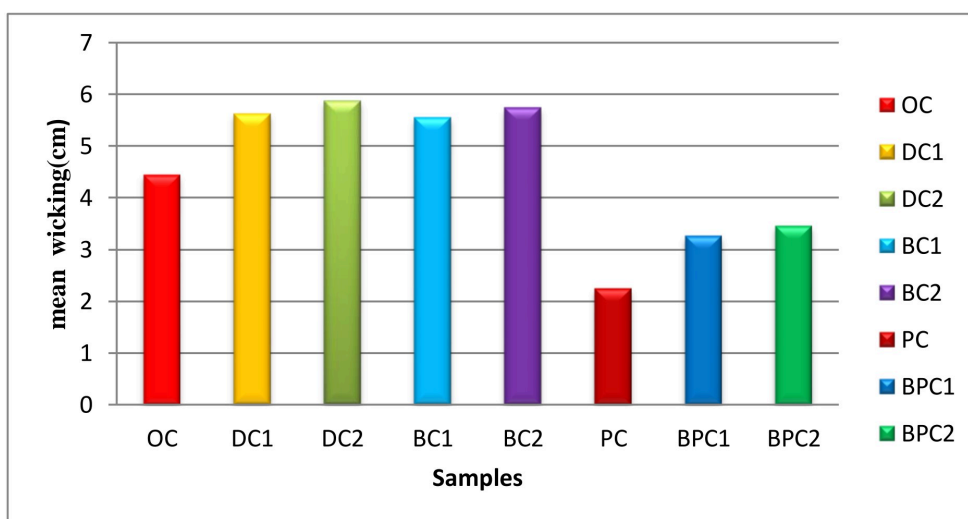


FIGURE –XII FABRIC WICKING-WARP

4.4.2.2 WICKING IN WEFT

The result of wicking of OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 among weft directions is presented in the Table XXVIII.

Table XXVIII

Fabric wicking in weft of original samples and treated samples

SAMPLE	MEAN	Gain/Loss over original	Percent Loss/Original	F Test	P value
OC	4.47	-	-	6.03	0.002*
DC1	5.22	0.75	14		
DC2	5.32	0.85	16		
BC1	5.36	0.89	17		
BC2	5.31	0.84	16		
PC	3.32	-	-	8.13	0.004*
BPC1	4.26	0.94	18		
BPC2	4.48	1.16	22		

*-Significant at 5% level ($p < 0.05$)

From the Table XXVIII is observed that the mean wicking of original sample is 4.47cm and 3.32cm. It has increased in treated samples. Hence it could be concluded that the absorbency rate increased in treated samples of weft.

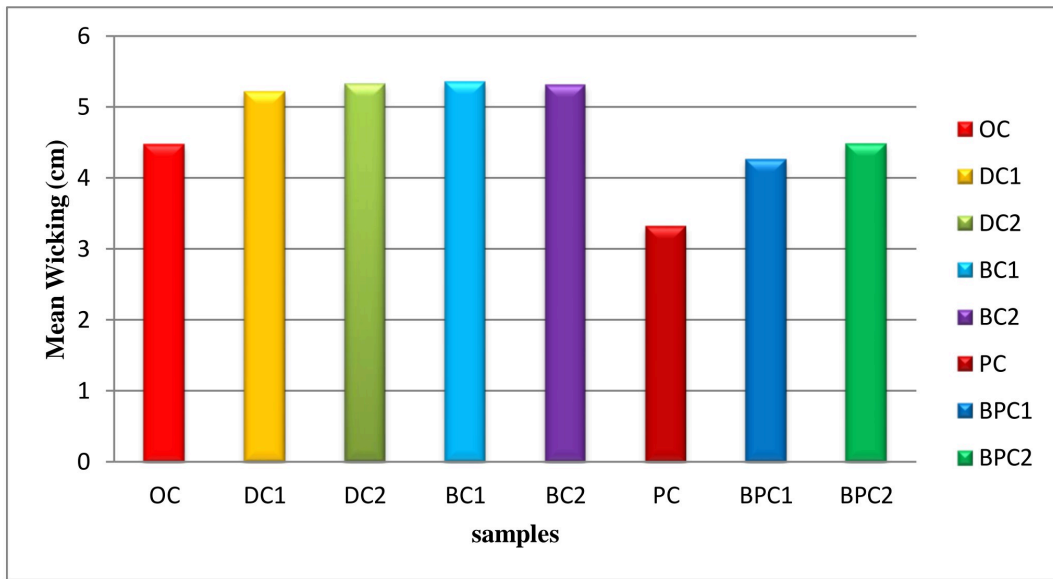


FIGURE –XIII FABRIC WICKING-WEFT

4.4.3 SPRAY TEST

The result of spray test of OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 samples.

Table XXIX

Spray test of original samples and treated samples

S.NO	SAMPLES	RATING	DESCRIPTION
1	OC	0	Complete wetting of whole of upper and lower surfaces
2	DC1	0	Complete wetting of whole of upper and lower surfaces
3	DC2	0	Complete wetting of whole of upper and lower surfaces
4	BC1	0	Complete wetting of whole of upper and lower surfaces
5	BC2	0	Complete wetting of whole of upper and lower surfaces
6	PC	0	Complete wetting of whole of upper and lower surfaces
7	BPC1	0	Complete wetting of whole of upper and lower surfaces
8	BPC2	0	Complete wetting of whole of upper and lower surfaces

From the Table XXIX is observed that the spray test of all sample is complete wetting of whole of upper and lower surface. Hence it could be concluded that the absorbency rate is equal in original samples and treated samples.

4.5 UPF Protection:

The UPF Protection test was carried out for the OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 in Table XXX

Table XXX

UPF samples of original samples and treated samples

S.No	SAMPLES	NO.OF SCAN	UPF	UVA Blocking(%)	UVB Blocking(%)	UPF Rating	Quality of protection
1	OC	5	15.52	94.24%	94.01%	16	good
2	DC1	5	45.92	97.50%	97.95%	46	Very good
3	DC2	5	79.80	98.55%	98.81%	80	Excellent
4	BC1	5	116.59	98.92%	99.21%	117	Excellent
5	BC2	5	142.95	99.12%	99.35%	143	Excellent
6	PC	5	5.77	72.67%	84.97%	6	poor
7	BPC1	5	13.22	90.89%	92.81%	13	poor
8	BPC2	5	22.65	94.70 %	95.78%	23	good

From the Table XXX it is observed that the original sample of cotton and polycotton UPF rating is 16 and 6. It has increased in samples DC1, DC2, BC1, BC2, BPC1, BPC2 by 46,80,117,143,13,23 of respectively. It is clear that the UPF rating was the maximum in BC2Hence it is concluded that the UPF rating increased after the treatment of boiling method *pelargonium hybridum* extract

4.6 MOSQUITO REPELLENT

The **Mosquito Repellency test** was carried out for the OC, DC1, DC2, BC1, BC2, PC, BPC1, BPC2 in Table XXXI

TABLE XXXI

Mosquito repellent of original samples and treated samples

S.NO	SAMPLES	Mosquitoes death count	Repellency	Quality
1	OC	0	0%	Poor
2	DC1	7	83%	Average
3	DC2	8	84%	Average
4	BC1	10	90%	Good
5	BC2	12	92%	Good
6	PC	0	0	poor
7	BPC1	10	90%	Good
8	BPC2	11	91%	Good

From the Table XXXI it is observed that the original sample of cotton and poly cotton Mosquito Repellency is 0 and 0. It has increased in samples DC1, DC2, BC1, BC2, BPC1, BPC2 by 7, 8, 10, 12, 10, 11 of respectively. It is clear that the Mosquito repellent death rate was maximum in BC2 and BPC2 .Hence it is concluded that the death count increased after the treatment ofboiling method *pelargonium hybridum* extract.

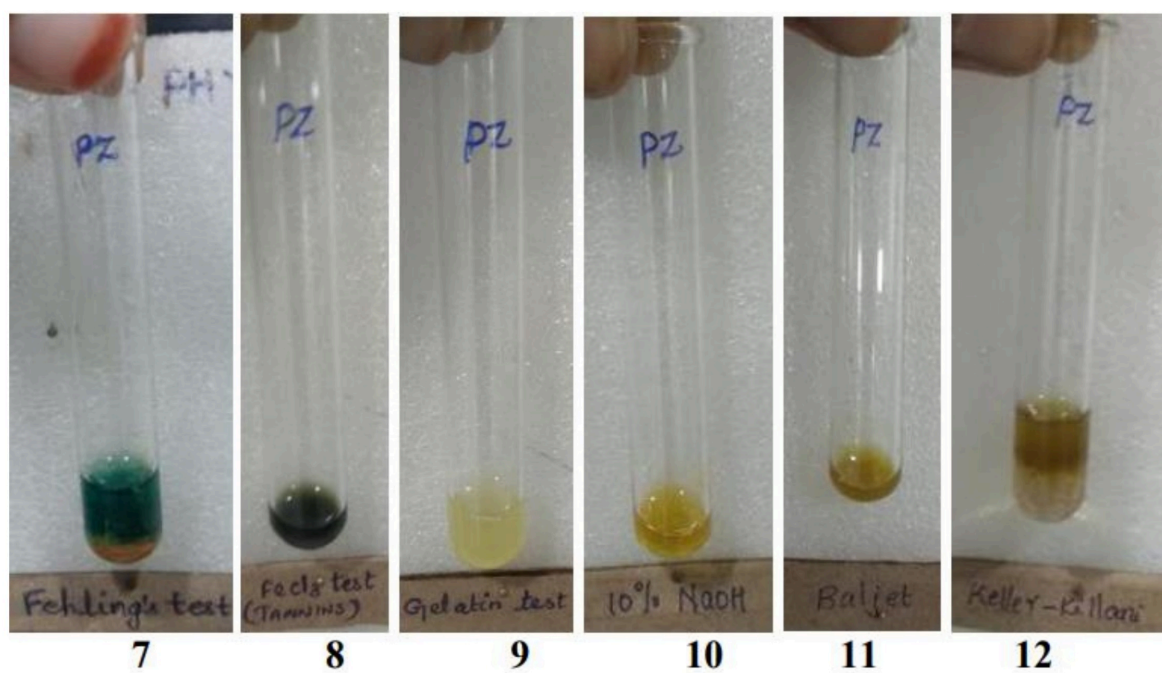
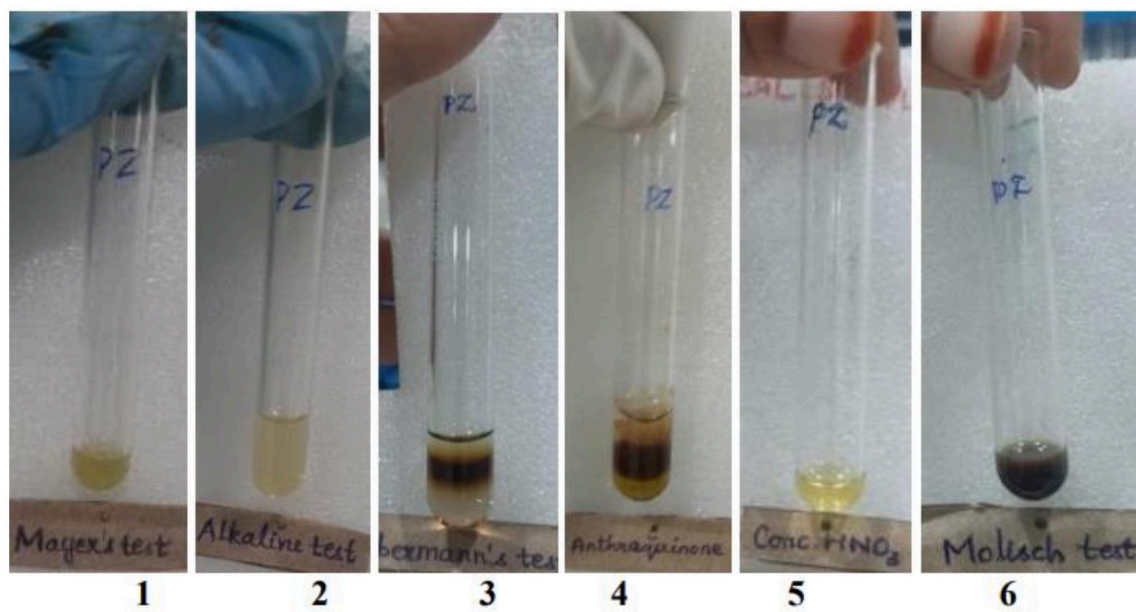


PLATE-V PHYTOCHEMICAL SCREENING

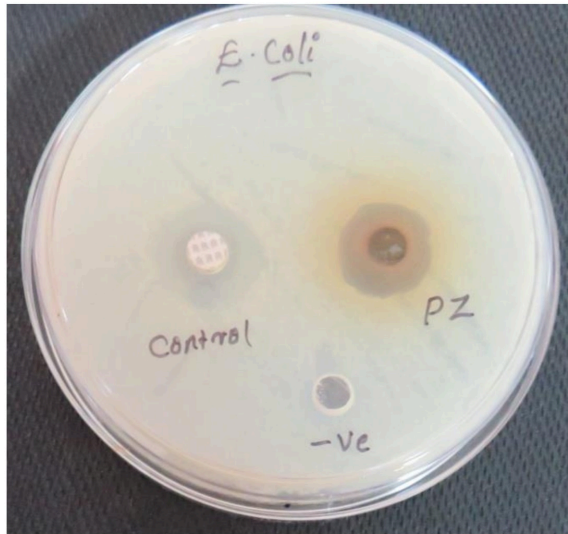


PLATE-VI ANTIBACTERIAL TEST

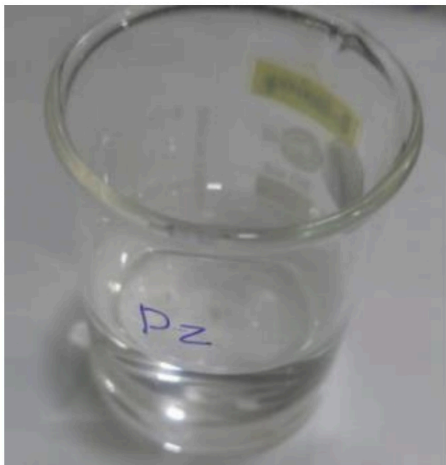


PLATE -VII TOXICITY



PLATE-VIII
GSM CUTTER



PLATE -IX
THICKNESS GAUGE

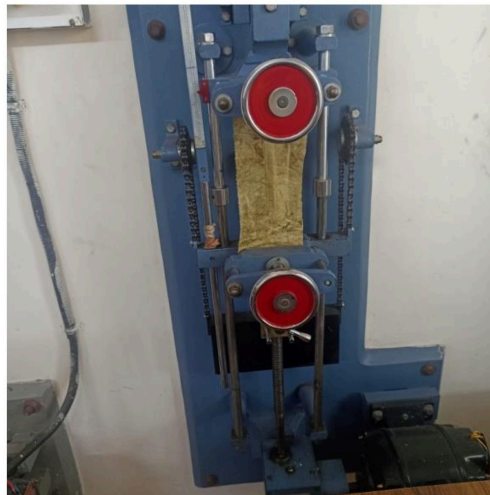


PLATE-X
TENSILE STRENGTH AND ELONGATION



PLATE-XI
ABRASION TESTER



PLATE-XII
STIFFNESS TESTER



PLATE-XIII
RUBBING TESTER



PLATE-XIV
SINKING TEST

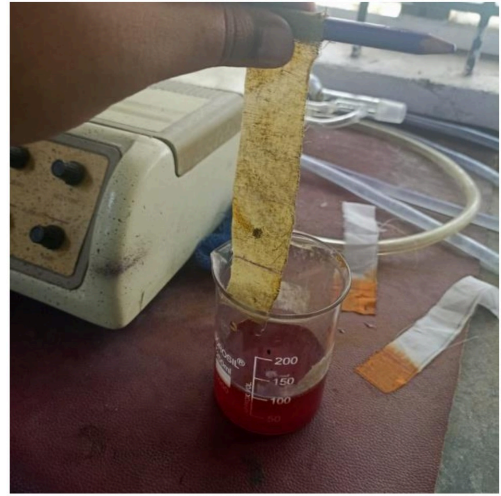


PLATE-XV
WICKING TEST



PLATE -XVI
SPRAY TEST

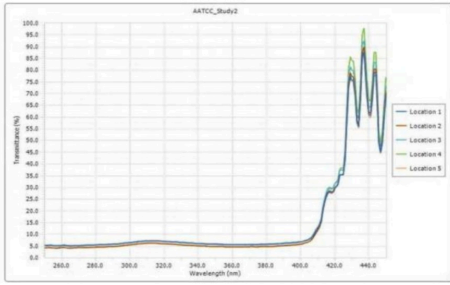


PLATE-XIX (UPF SAMPLE- OC)

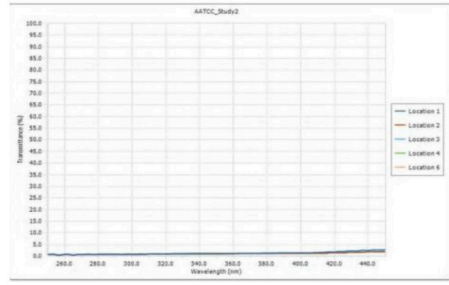


PLATE-XIX(UPF SAMPLE-BC1)

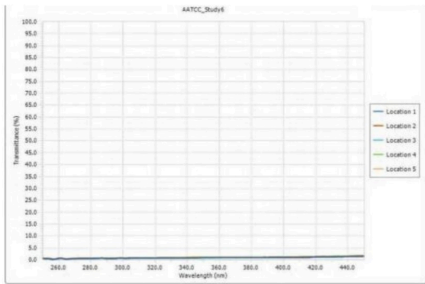


PLATE –XIX (UPF SAMPLE-BC2)

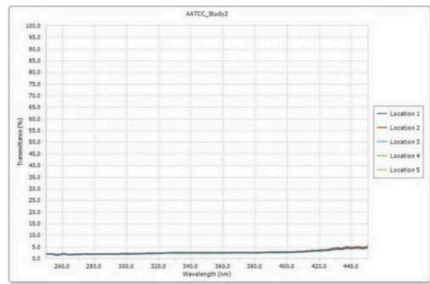


PLATE –XIX (UPF SAMPLE-DC1)

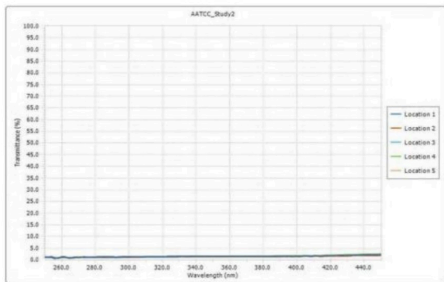


PLATE-XIX(UPF SAMPLES-DC2)

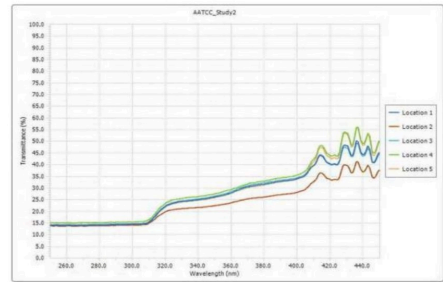


PLATE-XIX(UPF SAMPLE-PC)

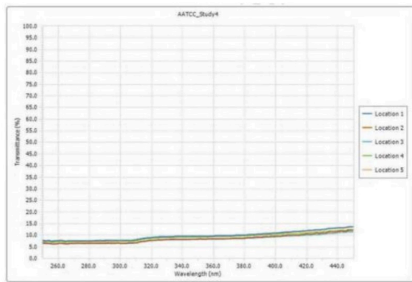


PLATE-XIX(UPF SAMPLE-BPC1)

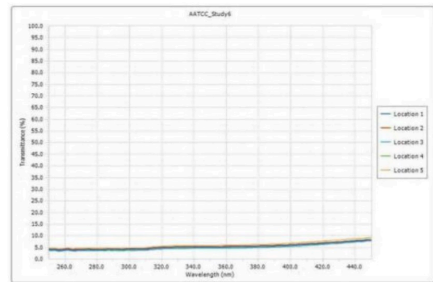


PLATE-XIX(UPF SAMPLE-BPC2)

PLATE-XVII UPF TEST SAMPLES

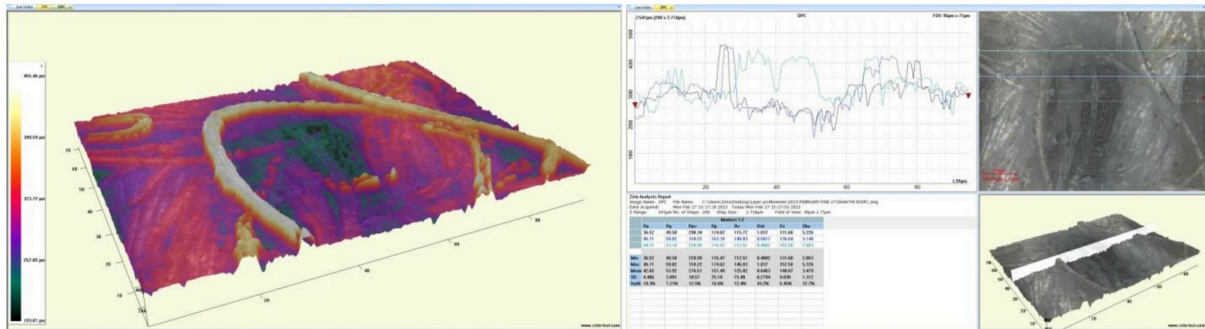


PLATE-XX (3D optical view and roughness of sample- PC)

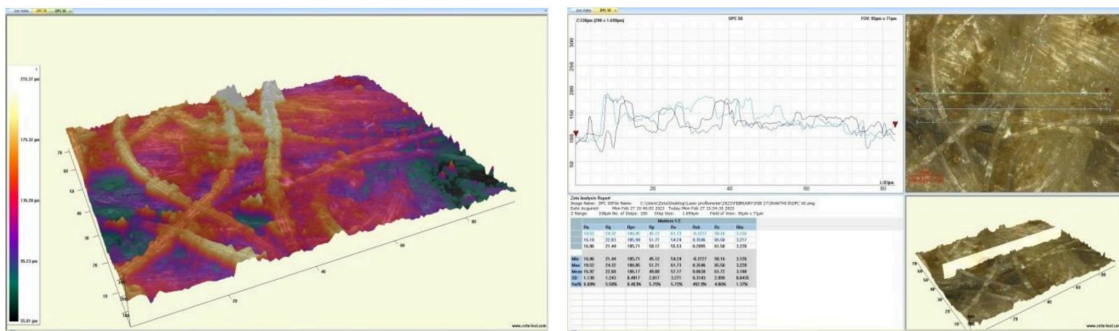


PLATE-XX (3D optical view and roughness of sample- BPC1)

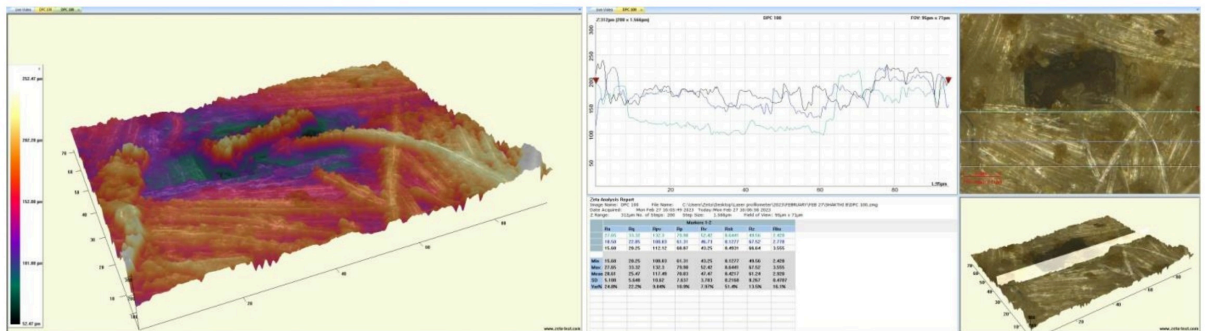


PLATE-XX (3D optical view and roughness of sample- BPC2)

PLATE-XX 3D OPTICAL VIEW AND ROUGHNESS OF SAMPLES

Summary and conclusion

5. SUMMARY AND CONCLUSION

With the development of industries the use of chemicals for production and finishing of textiles has also increased. This has enriched the textile production, but on the other hand this has also resulted in environmental issues. The result of pollution caused across the globe has pushed industries to go back into eco-friendly production methods. Every consumer is looking out for bio-degradable products. This has resulted the increased use of natural fibers and plant sources in the medical field. Moreover attraction in natural fibres leads to various design development and application for their eco-friendliness, accessibility, easy production and low cost. The increases in the use of chemicals have slowly deteriorated the health of soil and caused severe environment pollution

Plants contain good source of compounds which exhibit antimicrobial properties and it can be used in taking care of a range of illness. The growth of microbes is controlled when plant extracts are used in textile finishing. Therefore both textiles and antimicrobial property in plants is capable of combining together to increase benefits. A general lack of knowledge on conventional medicines, joined with the wish for a “natural” life style has ended in an escalating consumption of substitute or balancing therapies with the help of natural products in general and phytomedicines in particular. Protective clothing refers to garments and other fabric related items designed to protect the wearer from hazardous environment. The most prevalent hazard encountered in everyday life is the threat from the natural environment. The hazards include heat, cold, rain, snow, wind, abrasion, dust, microorganisms, nuclear radiation, the effects of static electricity and ultraviolet rays. Some of the herbal compounds obtained from plants are well known from time immemorial as anti-bacterial products. These plant products are applied directly on skin or wounds as paste or incantion either for skin care or wound healing. These natural products are abundantly available in nature and are widely distributed and the part of these plants applied to textiles. They are cheap and not processed and can be used as raw material required for applications. Apart from dyeing, these medicinal products possess distinct odour for identification and these are non irritant to skin and non toxic.

The objectives of the study were to

- To assess the multifunctional effect of selected extract
- To optimize the concentration of selected plant extract for finishing of cotton and poly cotton
- To treat cotton and poly cotton fabrics with plant extract.
- To evaluate the treated fabrics

EXPERIMENTAL PROCEDURE

Pre-treatment

The cotton fabric and polyester cotton fabric was selected for the study. In order to remove size and other natural and added impurities from the fabrics, the fabric is weighed and dipped in 20 liters of water with 70 grams of detergent powder at temperature of 60°C for one hour. After one hour, the fabrics was taken out and rinsed thoroughly under running water and dried in shade.

Herbal extraction procedure

For extraction wash the leaf of *pelargonium hybridum* and grind the wetted leaf with mixer. After grinding, using grey fabric on the top of the bottle put the grind substance in the cloth. And squeeze it, thus the liquid substance of *pelargonium hybridum* extracted.

Phytochemical Analysis

Leaf extract was subjected to the phytochemical screening using the method adopted. phytochemical screening revealed the presence of Alkaloids, flavonoids, Sterols, Anthraquinone, Proteins, Carbohydrates, Tannin, Cardiac glycosides were detected in aqueous method of leaf extract

Experimental procedure

Both cotton and poly cotton fabrics is finished using two different methods one is untreated fabric is dipped into the extraction solution for 24 hours and other is untreated fabric is heated into the extracted solution for 30mins. The fabric was treated with two different concentration of *pelargonium hybridum* extract liquid. 100 % extraction for dip and dry method and boiling method. 50% extraction and 50% distilled water for dip and dry method and boiling method. The material liquor ratio is 6:180. The multi functional finish of cotton and poly cotton fabric treated with the extract of *pelargonium hybridum* was carried out at optimized concentration with constant temperature for constant time interval. For dip and dry method is 24 hours and for boiling method is 30 minutes. For dip and dry method with two different concentration in room temperature. For boiling method with two different concentration in room temperature.

FINDINGS OF THE STUDY

- The general appearance of the treated fabrics was excellent. The texture of the fabrics treated were rate as soft. The brilliancy of colour is medium. Evenness of the fabric also rated to be even.
- Leaf extract possess antibacterial activity against bacteria namely *Staphylococcus aureus* and *E.coli*.
- The *pelargonium hybridum* extract is comparatively not toxic than $K_2C_{12}O_7$ which shows maximum lethality of shrimps at higher concentration. Hence it is concluded that the extract is not toxic
- Roughness test exhibits the highest Rp value and Rv value on untreated samples (151.49) compares to treated samples.
- Fabric weight BC2(124gm/sq.mt) and thickness BC2(0.51mm) highest value compared to original samples. All the treated samples increased gradually,
- Strength and elongation of the fabric increased in both warp and weft direction of all treated samples.
- Abrasion resistance of the fabric decreased in the entire treated sample after treatment.
- Stiffness BC2(3.5cm) increased in the fabric after finishing along warp direction and weft direction.

- colour fastness of treated samples to both wet and dry crocking shows an good result to all treated samples exhibits good fastness
- Wicking property in warp and weft direction has increased.
- The absorbency rate increased in the treated samples.
- Spray test were found to be equal for original samples an treated samples
- The UPF TEST conducted for *Pelargonium hybridum* extract showed excellent result when cotton fabrics through boiling method with 100%(143) and 50%(117) extract.
- Mosquito death rate was maximum against in BC2 (12) and BPC2(11).Death count increased while the fabrics treated by boiling method of *Pelargonium hybridum* extract after the treatment of boiling method *pelargonium hybridum* extract. The treated fabric has good result of mosquito repellency compared to original cotton and polyester cotton fabrics.

CONCLUSION

The extract from *Pelargonium hybridum* is the best suitable for the functional finishing of Cotton and Poly Cotton fabrics. The treated fabrics with the *Pelargonium hybridum* extract resulted in pale green colour. In addition treated cotton fabric possessed excellent UPF and mosquito repellent properties. while treated Poly cotton fabrics exhibits fair properties. Hence it may be concluded that the treated cotton fabric could be used for making Sun Protective Textiles, Sports Textiles, Medical Textiles and Home Textiles Products.

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Appendices

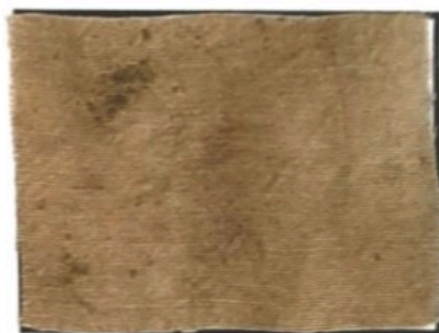
APPENDIX-1 COTTON ORIGINAL SAMPLES AND TREATED
SAMPLES



De-sized Cotton fabric



Dip and dry method with 50%
extract on Cotton



Dip and dry method with 100%
extract on Cotton



Boiling method with 50%
extract on Cotton

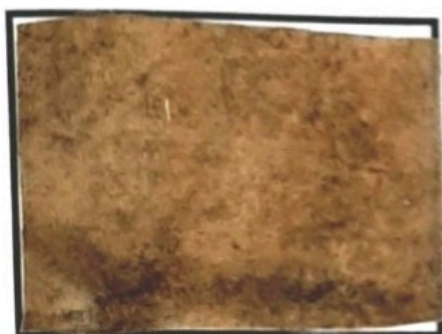


Boiling method with 100%
extract on Cotton

APPENDIX-2 POLY COTTON ORIGINAL SAMPLES AND TREATED
SAMPLES6



De-sized Poly Cotton fabric



Boiling method with 50%
extract on Poly Cotton



Boiling method with 100%
extract on Poly Cotton