Anti-bacterial and Mosquito repellent efficiency of Woven and Nonwoven fabrics treated with Mexican Sunflower Leaf extract

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MASTER OF SCIENCE IN TEXTILES AND FASHION APPAREL

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Certified as Bonafide Research Work

Signature of the
Head of the Department

Signature of the Supervisor

DECLARATION

I declare that the dissertation entitled "**Anti-bacterial and Mosquito repellent efficiency of Woven and Nonwoven fabrics treated with Mexican Sunflower 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. 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 -641043 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.

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CERTIFICATE FROM THE SUPERVISOR

I certify that dissertation entitled "**Anti-bacterial and Mosquito repellent efficiency of Woven and Nonwoven fabrics treated with Mexican Sunflower Leaf extract**" submitted for the degree of Master of Science (M.Sc.,) Textiles and Fashion Apparel by ROSHNI.K (21PTF016) 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

15/3/23

Signature of the HOD

Signature of the Supervisor with Designation

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CONTENT

CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDIX

1. INTRODUCTION

Textiles have always played a central role in the evolution of human culture by being at the forefront of both technological and artistic development. The protective aspects of textiles have provided the ground for innovative developments, (Aswini et al 2010). Textiles have such an important bearing on our daily lives that everyone needs to know something about them. From earliest times, people have used textiles of various types for covering, warmth, personal adornment, and even to display personal wealth. Today, textiles are still used for these purposes and everyone is annual time consumer, (Singh 2008). 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 antimicrobial properties, (Ramachandran et al 2004). A finish is a treatment given to a piece of fabric to change appearance, handling/touch, or performance. Certain textile material treatments are applied to improve the look and qualities of textile goods. These treatments are called finishes. The purpose is to make the fabric more suitable for its end use. The finishes may be basic or functional. Basic finishes, also called aesthetic finishes, are applied to almost all the fabrics to improve their appearance, feel, and body. Functional finishes are applied to improve the performance of fabric for some specific purpose, for example, fireproof, waterproof, bulletproof, crease-resistant, insect repellent and antimicrobial finishes (Kalia.,2014).

Now textile industries all over the world are facing challenges in the field of quality and productivity, due to the globalization. The highly competitive atmosphere and the straight ecological parameters have ensured that the prime concern of the textile processor is quality and environment. Again, the guideline of the processes thus in turn, makes it essential for innovations and changes in the processes. As a result, the research and development strategies of the textile processors will be highly focused and the challenges will face many changes in the textile industry.(Prabha,.2023). The textile industry is currently moving away from being a conventional craft to developing high-tech and fashion products. This necessitates the need for the utilization of sustainable and modern manufacturing methods. (Prabha,.2023)

Eco-friendly products are highly beneficial to our health as also to the environment. The quality of our lives can be greatly improved with the use of these green products that are made from natural raw material. The manufacturing of these products causes minimal harm to the environment. Textiles were first developed as a means for carrying food, as mats in shelters and later used as clothing. Cotton is the most popular amongst the fibres admired by the consumer all over the world for its fascinating feel, comfort and versatility (Malikprem, 2007).

In a country like India, with extremes of temperature and humidity garments made from natural fibres in cotton or blends of man-made and natural fibres are certainly preferred purely for the reason of environment and health (Sangwan et al., 2006). Cotton fabrics are very popular in a tropical country like India (Anita, 2011).

Bacteria are unicellular organisms which can grow very fast under warm and moist conditions. It can be divided into two groups. Gram positive and gram negative (Srikanth, 2010). Anti-bacterial textiles continue to increase the popularity as the demand for fresh smelling, skin friendly and high performance fabric. This finished fabric can minimize the transfer of microorganisms on the wearer by creating a physical barrier. (Khurana, 2011).

Bacteria, either pathogenic or not, are normally found on human skin, nasal cavities, and other areas, such as the genital area (Sheikh.,2019). Typically, pathogenic bacteria like *Escherichia coli* and *Staphylococcus aureus* have been found on textiles (Kang.,2016). The negative role of microorganisms in the textiles leads the researchers to the development of textiles with antibacterial properties. With this growth in health awareness, many people focused their attention on educating themselves about and protecting themselves from harmful pathogens (Herrera.,2006). It soon became more vibrant for antibacterial finished textiles to protect the user from bacteria rather than simply protecting the garment from fiber degradation Requirements for antimicrobial agents on textiles concern safety (producer and user), wash, and heat fastness and applicability without negative effects on the textile properties. (Thilagavathi, 2007).

Among all the natural antimicrobial agents, the plant products comprise the major segment. Healing power of some of the plants have been used since ancient times. Medicinal plants are the gift of nature which helps in curing limitless number of diseases among human beings. The richness of plants on the earth surface has directed to an increasing interest in the study of different traditional medicinal plant extracts as potential sources of new antimicrobial agents. Herbs are abundantly available in nature and are non-toxic and inexpensive. (Bernard,2000) Extract from plant parts such as leaves, roots, seeds and flowers display antimicrobial properties. Due to their eco-friendly nature, herbal finishes are gaining significant momentum. Antimicrobial extracts can be used as textile finishing agents in solvent form or microencapsulation and nanoencapsulation to improve the durability and controlled release of the extracts. This finish is applied in such a way that appearance and feel of the fabric is not altered and no chemical odour remains. These are applied to textile materials for two purposes as to protect the wearer and the fabric itself.

An insect repellent help in preventing and controling the outbreak of insect-borne diseases such as malaria, dengue fever. Most plants contain compounds that they use in preventing attack from phytophagous insects. “Natural” smelling repellents are preferred because plants are perceived as a safe and trusted means of mosquito bite prevention. Plant-based repellents have been used for generations in traditional practice as a personal protection measure against host-seeking mosquitoes. (Debboun, 2006)

Mosquito repellent textiles is one of the revolutionary ways to advance the textile field by providing the much-needed features of driving away mosquitoes, especially in the tropical areas. It protects the human beings from the bite of mosquitoes and thereby promising safety from the mosquito-bornediseases, such as malaria, Dengue Fever (DF), Nile fever, Dengue Hemorrhagic Fever (DHF), chickungunya and filariasis, which are serious public health problems in tropical regions, especially in Africa and Asia. These diseases are transmitted to human beings through mosquito bite only. Prevention of mosquito bites is one of the main strategies to control or minimize incidence of these diseases. (Gopalakrishnan, 2006).

There are several mosquito repellents are available in today's market, for instance, an estimated 110 million people safely use Di-EthylMeta Toluamide (DEET) worldwide each year developed by the US Department of Agriculture, DEET was first used by the military. It is applied as a skin lotion and its effectiveness last for four to five hours. DEET cannot be applied on fabric. Because it does not withstand after few laundry. People initially applied mosquito repellents on their skin directly as lotion. It is effective for a few hours and most of them can be harmful to human beings as they are coming in direct contact with the skin. To impart this character a finish of the mosquito repelling agent is given to the textile material. Due to these reasons, people now prefer mosquito repellent textiles, as they may remain effective for up to a week when applied in clothing. A repellent applied to clothing normally retains its effect longer than on skin .Generally, cotton and nylon fabrics are treated with mosquito repellents since cotton is widely used as bed-sheets where nylon as mosquito nets. (Joice, Y.S. 2010)

In order to reduce the risk of malaria providing mosquito repellent finish to cotton fabrics is very important. Implementing this project in small scale level with less investment cost and with less skill and knowledge helps in a achieving the health strategy of the country and saves society. Till now malaria is an unsolved problem in Ethiopia and other countries. For that matter DDT is the most used chemical in Ethiopia. Treated bed nets are also used. Some lotions are also available. But all the above synthetic chemicals have side effects, so it is necessary to replace them with natural products which can be prepared locally (Afaf Farag,2011)

Cotton is the natural vegetable fiber which is of great economic importance when considered as a raw material for cloth. Organic cotton is grown using methods and materials that have low impact on the environment. Organic production systems replenish and maintain soil fertility, reduce the toxicity and fertilizer and build biological diverse agriculture. (NIIR Board, 2004)Textile finishing usually includes treatments such as scouring, bleaching and dyeing. (Rajendran, 2009).

Tithonia diversifolia (Mexican sunflower) is a robust plant that can vary significantly in habit. Sometimes an unbranched or sparsely-branched annual, it can also be a short-lived perennial, or the plant can become shrub-like with more or less woody stems. It can grow from 1 - 5 metres. The plant is harvested from the wild for local use as a medicine and fuel. It is sometimes grown as companion plant, helps in improving quality of the soil and increase the yields of wide range of crops. It is also often grown as an ornamental. The leaves contain sesquiterpene lactones, including tagitinine, which possess insecticidal properties. A study shows that it possesses antimicrobial activity and is active against both gram-positive and gram-negative bacteria. This suggesting that the leaves can be used in treating gastrointestinal infections, skin diseases and urinary tract infections. A bitter, essential oil is extracted from the leaves. It has a repellent activity on the mosquito *Anapholes gambiae*, and a smaller, but still significant, action on other species of mosquito. (Lebas F., 2016)

In this research, "**Anti-bacterial and Mosquito Repellenct Efficiency of Woven and Nonwoven Fabrics Treated with Mexican Sunflower Leaf Extract"** with the following objectives,

- To optimize the concentration of selected plant extract for finishing woven and non-woven material.
- To analyse the multifunctional efficiency of selected plant extract
- To finish the woven and non-woven fabrics with selected plant extract
- To assess the multifunctional effect of plant extract finished on woven and non-woven fabrics.

1. REVIEW OF LITERATURE

The review of literature pertaining to the study "**Anti-bacterial and Mosquito repellent efficiency of Woven and Nonwoven fabrics treated with Mexican Sunflower Leaf extract"** consist of following headlines

2.1 Natural source

2.1.1 Extraction from herbal source

2.2 woven and Nonwoven

2.3 Cotton

2.3.1 Characteristics of cotton

2.3.2 Properties of cotton

2.3.3 Advantages of cotton

2.4 Plant Authentication

2.5 Phytochemical screening

2.6 Antimicrobial agent for textiles

2.7 Mosquito repellent

2.1 Natural source

Tithonia Diversifolia is a species of flowering plant in the family Asteraceae that is commonly known as the tree Marigold, Mexican tournesol, Mexican sunflower, Japanese sunflower or Nitobe chrysanthemum. It is native to Mexico and Central America but has a nearly pantropical distribution as an introduced species. Depending on the area they may be either annual or perennial. It has shown great potential in raising the soil fertility in soils depleted in nutrients. (Muyekho,. 2007) Originating in Mexico; research has shown its potential in benefiting poor African farmers. (Jama et al. 2000) This plant is a weed that grows quickly and has become an option as an affordable alternative to expensive synthetic fertilizers. (Jama et al. 2000) It has shown to increase plant yields and the soil nutrients of nitrogen (N), phosphorus (P), and potassium (K).

Kingdom: platae

Clade: Tracheophytes

Clade: Angiosperms

Clade: Eudicots

Clade: Eudicots

Order: Asterales

Family: Asteraceae

Genus: Tithonia

Species: *T. diversifolia*

The leaves contain a bitter essential oil. A decoction of the leaves is sometimes used in the treatment of malaria. An infusion of leaves is used in the treatment of constipation, stomach pains, indigestion, sore throat and liver pains. Leaf extracts are used externally for the treatment of wounds and haematomas.

2.1.1 Extraction from herbal source

Extraction is the crucial first step in the analysis of medicinal plants because it is necessary to extract the desired chemical components from the plant material for separation. The basic operation includes steps, such as pre washing, drying of plant material of freeze drying, grinding to obtain homogeneous sample. The selection of solvent system largely depends on the specific nature of the bioactive compound. (Meenakshi Rastogi, 2009)

2.2 Woven and Nonwoven

The yarn is made into fabric through different manufacturing processes such as weaving, knitting and non-woven. In this weaving is more popular and then others. Weaving is one of the processes of manufacturing fabric. It consists of two series of thread of the warp and weft directions interlaced at right angles to each other. The warp threads run the length of the fabric and the weft thread run across the width of the fabric (Vidyasagar, 2005). Fabrics are classified as to weave or structure according to the manner in which warp and weft cross each other. The three fundamental weaves of the plain, twill and satin weave (Thomas, 2006). The woven fabric as soon as it comes out of the loom consisted of more impurities and natural colour, because of this the finishing and dyeing won't get uniform on the fabric. Hence, in textile industry the basic finishes are given to the fabric to remove natural impurities and natural colours. (Midgley, 2007)

Mankind has been making use of fabrics since ancient times. We wear garments made of fabrics, sit on upholstery that is mostly fabric and sleep on sheets made of these fabrics. One of the most common ways of making fabrics is weaving. However, in addition to woven fabrics, there is another category of fabrics that is non-woven. These fabrics have been around us and also in use for quite some time though many of us do not know the difference. (Neelakandan.,2006)

The threads or yarn goes through a process called weaving to be converted into a fabric. In weaving, two or more threads run in perpendicular to each other, to make a pattern called warp and waft. Warp threads run up and down the length of the fabric while waft threads run sideways across the fabric and this weaving of the two threads creates a woven pattern call fabric. Waft threads go over the warp thread and then they go under the next warp thread. (Malik Prem, 2007)

Plain weave, also called Tabby Weave, simplest and most common of the three basic textile weaves. It is made by passing each filling yarn over and under each warp yarn, with each row alternating, producing a high number of intersections. Plain-weave fabrics that are not printed or given a surface finish have no right or wrong side. They do not ravel easily but tend to wrinkle and have less absorbency than other weaves. (Malik Prem, 2007)

Nonwoven fabrics are made by placing together several fibres and pressing them using heat and pressure to create a fabric. Sometimes adhesive is also used to convert fibre into nonwoven fabrics. (Mel Schwartz, 2010). The properties of the spunlace nonwovens are influenced by the web formation and hydro entangling process. Over the past decades, scientists have investigated that how the web properties influence the transfer of specific energy, the fiber entanglement and reorientation and thereafter the properties of the final material. (Mel Schwartz, 2010).

Predominantly cotton woven and nonwoven material are the basic fundamental of textile which is been used for this study. Closely woven is best for more strength or greater protection, while open or loose weave is better for absorbency. Woven material which allows fluids from the extract to be absorbed into the fibres, wicked away, or passed through into other absorbent material. Nonwoven material has higher absorbency rate and wicking rate in comparison with woven. As because the fibres are distributed over the nonwoven fabric, it helps in holding more fluids. Hence woven and nonwoven materials were prepared for this study. (Balaji,. 2010).

2.3 Cotton

Cotton is one of the oldest known fibre some of the earliest fabric relics found in excavations of ancient civilisations have been cotton. Archaeologists found cotton fabric 5000 years old at Mohenjo Daro, an ancient town in the Indus River valley of west Pakistan. and similarly aged examples have been found in Egypt and in Mexico (Gienandt, 2006). Cotton is the purest source of cellulose and the most significant natural fibre. The specific chemical composition of the cotton fibers vary by their varieties, The primary cell walls of the cotton fibers contain less than 30% cellulose and it has lower molecular weight. The secondary wall of the cotton fibre is nearly 100% cellulose. The structure of the cotton fibers can be Viewed along the fiber axis and across the fiber section. Cotton fibers are the largest single cells in nature. Some matured fibres can reach upto 4,000 times in length of their diameters. Both the fibre length and the secondary wall thickness arc increased with higher potassium supply during growth. Drying of fibers involves the removal of fluids from the cellulose. The strength of the cotton fibers is attributed to the rigidity of the cellulosic chains, the highly fibrillar and crystalline structure. (Tortora, P.G., 2001)

Although the cotton plant is thought to have initially grown wild in east Africa, it was first cultivated in the country noy known as Pakistan where its early uses were as a textile for clothing, bindings for sandals and harnesses for elephants. The Greek historian, Herodotus (484 - 42s BC) Wrote about a tree in Asia that bore cotton exceeding in goodness and beauty (Gienandt, 2006).

Successful cultivation of cotton requires a long frost-free period, plenty of Sunshine, and a moderate rainfall., usually from 60 to 120 cm. Soils are usually heavy, although the level of nutrients does not need to be exceptional. In general, these conditions are met with the seasonally dried tropics and subtropics in the northern and southern hemispheres, but a large proportion of the cotton grown today and it is cultivated in areas with less rainfall that optain the water from irrigation. Production of the crop for a given year usually starts soon after harvesting the preciding autumn. Naturally coloured cotton can come in red, green and several shades of brown. (wang.,2009)

2.3.1 Characteristics of cotton

One of the inherent characteristics that makes cotton "King" among fibers and enhances consumers' appeal is its comfort characteristics. Comfort here does not refer to the psychological comfort but to the physiological comfort such as the moisture vapor transport rate (MVTR). The rate at which water vapor moves through a fabric plays an important role in determining the comfort as it influences the human perspiration and the cool/warmth feeling. Human body produces moisture in the form of perspiration, which should leave the microclimate between the skin and fabric before condensation to avoid clinging of fabric on to skin, keeping the fabric and skin surface dry (Riello Giorgio,2013)

When a fabric allows the transport of water vapor at a faster rate, it is said to be a breathable fabric. In other words, the faster a fabric breaths the better is its comfort. This property has direct implication on the end use application, consumer appeal and sales value of the fabric. More importantly, in the case of cotton, its inberent characteristic is its comfort (Regan, 2006). By controlling the moisture vapor transport properties of 100% cotton, it was possible to develop a wide range of performance apparel fabric for athletic activities (Anonymous, 2002)

2.3.2 Properties of cotton

Cotton holds its own place as a textile material because it has properties very different to those of other fibres. Fabrics containing cotton are comfortable and have an aesthetic appearance. The hydrophilic character of cotton coupled with high fibre tenacity, easy care and rapid moisture absorption and desorption properties some other factors that have led to the development of a wide variety characteristic textiles ranging from apparel fabric through household furnishing to artist's canvas. Such substrates need to be subjected to various chemical treatments for value addition. Typical treatments, such as scouring, bleaching and biopolishing, aim at improving the absorbency, level of whiteness and surface properties of the aforesaid products (Armstrong Thomas,1962)

Conventional method of scouring cotton textiles under high temperature alkaline conditions 1s associated with number of problems. Another approach used to produce specific finishing effect on cellulosic textiles is enzymatic scouring. In comparison with alkali scouring, it offers significant advantages including lower effluent generation, water pollution and quite good soft action. Hydrogen peroxide is a strong bleaching agent that destroys natural colouring pigments and imparts degree 01 whiteness. Biopolishing is the core technology developed for the removal of protruding fibre from cotton material, and it is an effective way to improve material softness, smoothness and fashionable appearance (Aspirin, 2008)

The cotton fibers are mainly made up of cellulose. Cellulose does not form unless temperature is over 70°F. The cotton fibers are attached to the seeds inside the boll of the plant. The length of these fibers is the main determining factor in the quality of the cotton. Staple lengths are made divided into short, medium and long.

- Comfortable: There are no surface characteristics of cotton that make it irritating to the human skin. Cotton feels good against skin; it has a soft hand.
- Hydrophilic: Cotton has a natural affinity for water- it attracts moisture away from your body.
- Moisture passes freely through cotton- aiding in evaporation and cooling.
- Good heat conductivity: Cotton allows heat to dissipate making it a wonderful fiber to maintain a comfortable sleeping temperature.
- Strong and abrasion resistance.
- The unfavourable attributes of cotton include its lack of resiliency (cotton tends to wrinkle) and its lack of luster.

2.3.3 Advantages of cotton

Cotton is soft and comfortable. It is hypoallergic and won't irritate sensitive skin or cause allergies. Cotton is all natural and doesn't contain chemicals. Cotton fabric are highly breathable and allow air circulation that discourages the growth of fungus in dark and moist environments. Cotton is perfect for wearing in the summer, as it can easily absorbed by body and keep you cool and comfortable in hot weather (Beckret Sven, 2014)

2.4 Plant Authentication

Medicinal plants cover a wide range of plant taxanomy and closely related species. There is an increasing international market for medicinal plants, which are used both for herbal medicine and for pharmaceutical products. Accurate and rapid authentication of plants and their respective adulterants is difficult to achieve at the scale of international trade in medicinal plants. The natural medicines are much safer than synthetic drugs, have gained popularity in recent years, leading to a tremendous growth of phyto-pharmaceutical usage. However, herbal medicines can be potentially toxic to human health and sometimes may cause unknown effects. The recent investigations have revealed that many plants used in traditional and folk medicine are potentially toxic and mutagenic (Matthews et al., 2003)

Due to the complex nature and inherent variability of the chemical constituents of plant-based drugs, it is difficult to establish quality control parameters. Due to the popularity of herbal drugs globally, their adulteration or substantiation aspects are gaining importance at the commercial level. Pharmaceutical companies are procuring materials from traders, who are getting these materials from untrained persons from rural or forest areas. Developing Herbal Antimicrobial finished Cotton fabric for mosquito. Misidentification of herbs can be non-intentional orienentional. Adulteration can occur due to ignorance or intentional substitution with cheaper plant material and may cause damage to human body. Therefore, authentication at various stages, from the harvesting of the plant material to the final product, is a need of the hour. The general approaches to herb identification are dependent on morphological (Khan et al, 2011)

2.5 Phytochemical screening

Phytochemicals are natural bioactive compounds found in plants and are divided into two groups; primary and secondary compounds. These compounds are classified according to their functions in plant metabolism. Amino acids, sugars, proteins and chlorophyll are known as primary compounds while secondary compounds consist of alkaloids, terpenoids, phenolic compounds and many more (Krishnaiah et al, 2009). There are several known phytochemicals and are non-nutritive that have protective or disease preventive properties. These chemicals are produced by plants to protect itself, and they can also protect humans against diseases (Okigbo et al, 2008).

Some of the well-known phytochemicals are lycopene in tomatoes, isoflavones in soy and flavonoids in fruits (Okwu, 2005). They are not essential nutrients and are not required by the human body for sustaining life. The different phytochemicals such as Volatile oils, Alkaloids, Glycosides, Flavanoids, Tannins and Polyphenolic compounds, Carbohydrates, Proteins, Fixed oils and Fats, Terpenoids (Cowan, 1999), found in medicinal plant parts are precursors for the synthesis of useful medicines (Sofowora,1993).

Phenols are a member of a group of aromatic chemical compounds with weakly acidic properties and are characterized by a hydroxyl (OH) group attached directly to an aromatic ring. The simplest of phenols 32 derived from benzene is also known as phenol and has the chemical formula C_6H_6OH. The presence of phenols is considered to be potentially toxic to the growth and development of pathogens (Okwu and Okwu, 2004).

Phenolic compounds may reduce risks of many infectious diseases. The use of traditional medicine mainly derived from plant sources has become an attractive segment in the management of many lifestyle diseases. Polyphenols are secondary metabolites of plants and are generally involved in defense against ultraviolet radiation or aggression by pathogens (Pandey et al, 2009).

Flavonoids are 15-carbon compounds generally distributed throughout the plant kingdom. They are known to be synthesized by plants in response to microbial infection and have been found in vitro to be effective against a wide array of microorganisms (Harborne, 1973). This group has a common basic structure consisting of two aromatic rings bound together by three carbon atoms that form an oxygenated heterocycle. More than 4,000 varieties of flavonoids have been identified, many of which are responsible for the attractive colours of flowers, fruits and leaves. Based on the variation in the type of heterocycle involved, flavanoids may be divided into six subclasses. Flavanoids are potent water-soluble super antioxidants and free radical scavengers which prevent oxidative cell damage (Kyselova, 2011). They have strong anti-cancer activity and protect against all stages of carcinogens. Flavanoids are well known to reduce the risk of heart diseases in patients (Urquiaga and Leighton, 2000).

Alkaloids rank among the most efficient and therapeutically significant plant substances. Some 5,500 alkaloids are known and they comprise the largest single class of secondary plant substances which contain one or more Nitrogen atoms, usually in combination as part of a cyclic structure. For thousands of years, indigenous groups around the world discovered, through self-experimentation with locally available plant extracts, that they could provide materials for hunting prey, culinary enhancement, amelioration from disease, relief of pain, and healing for 200-year period, many alkaloids became critical components of the global pharmaceutical armamentarium, and tremendous healing has resulted from their clinical application (Amirkia and Heinrich, 2014).

Quinones have aromatic rings with two or more ketone substitutions. The natural quinone pigments range in colour from pale yellow to almost black and Developing Herbal Antimicrobial finished Cotton fabric for mosquito swatches. These compounds are responsible for the browning reaction in cut or damaged fruits and vegetables and are an intermediate in the melanin synthesis pathway in human skin.Quinones are of interest from a medical and toxicological perspective due to their unique reactivity and high prevalence in the environment (Madeo et al, 2013).

Tannin is a general descriptive name for a group of polymeric or phenolic substances capable of tanning leather or precipitating gelatin from a solution, and astringency (Harborne, 1973). They are divided into two groups, namely hydrolyzed and condensed tannins. Many physiological activities such as stimulation of phagocytic cells and wide range of anti-infective action have been assigned to tannins (Okwu and Okwu, 2004).

Terpenoid essential oils are the main compounds found in the volatile steam distillation fraction responsible for the characteristic scent, odour or smell found in many plants. Some essential oils possess medicating properties and are used in the pharmaceutical industry (Krishnaiah et al,2009).

Herbs and spices produce these bioactive compounds which react with other organisms in the environment to exhibit antioxidant activity and inhibit bacterial and fungal growth. The majority of the active compounds are phenols, vitamin C, vitamin E, tannins and carotenes (Aqil et al, 2006; Thitilertdecha et al,2008). Sources of natural antioxidants are primarily plant phenol such as flavanoid that exhibit antioxidant, antimicrobial, anti-carcinogenicity and other biological active compounds (Demiray et al, 2009; Mohan et al, 2008; Sengul et al,2009). The substances that inhibit the growth of pathogens and are least toxic to host cells are considered good medium for development of new antimicrobials. The extraction process of phytochemicals in enormous amount by rapid and accurate methods of screening plants for antimicrobial product development (Banso and Olutimayin, 2001) are recently emerging procedures. Many phytochemicals originally rare in occurrence are of almost universal distribution in the plant kingdom contain physiologically active principles that over the years have been exploited in the traditional system of medicine for the treatment of Developing Herbal Antimicrobial finished Cotton fabric for mosquito swatches (Adebajo et al, 1983). There is a reasonable likelihood that medicinal plants with a long history of human use will ultimately yield novel drug prototypes (Eshrat and Hussain, 2002).

Phytochemical investigation of crude plant extracts is very important with regard to their potential pharmacological effects. With the advent of separation techniques and instrumental analysis, it is possible to perform physical evaluation of a crude extracts, which could be both qualitative and quantitative in nature (Grover et al, 2014)

2.6 Antibacterial activity

An important and growing part of the textile industry consists of the medical and related healthcare and hygiene sectors. A hospital contains an enormous amount of textiles with the added threat of high volumes of traffic. Because of the continuous flow of people, particularly those with infectious diseases, both patients and employees are at risk of cross transmission of diseases and other health issues. The increasing rate of drug-resistant bacteria also heightens the importance of finding safe and durable antimicrobial finishes (Chinta, 2013)

The medical textile industries have always played an important role in the protective aspects of fabrics. The fabrics have long been recognized as a good support medium for the growth of microbes. A microbe on textile causes the unwanted effects to both the wearers and textile itself. The negative factor of the microbes has resulted in the development of innovative and hygienic finishes on textiles. The consumers are also demanding for the hygienic clothing which Developing Herbal Antimicrobial finished Cotton fabric for Mosquito swatches in antimicrobial textile products. Antimicrobial finish prevents the growth of bacteria. Anti-microbial textiles with improved functionality find a variety of applications such as infection control and barrier control (Rajendran et al,2016).

2.7 Mosquito repellent

As the Global warming increases the distribution of mosquitoes also increases. Now a days escaping from mosquito become the greatest task. Mosquitoes are the carrier of many diseases. Due to our carelessness these diseases are caused. We need to protect our self in order to escape from those diseases. Though there are many lotions and creams available to repel the mosquitoes, they are limited in their use. This may cause some ill-effects to the skin. A mosquito repellent textile is one such textile product emerges recently. It protects the human from the mosquito bite and there by promising safety from diseases like Dengu. A mosquito repellent finish can be applied to the textile material either by natural or chemical repelling agents. (Monisha Gracin Edith,2020)

Mosquito repellent textiles are one of the revolutionary ways in advance. The textile field provides the much needed features of driving away 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. Natural herbs carry herbal property will be beneficial to the human body (Deepak et al., 2011).

2. EXPERIMENTAL PROCEDURE

The experimental procedure pertaining to the study "**Anti-bacterial and Mosquito repellent efficiency of Woven and Nonwoven fabrics treated with Mexican Sunflower Leaf extract"** consist of following headlines

3.1 Selection of Source

3.1.1 Preparation of extract from the selected source

3.1.2 Extraction of the source

3.2 Phytochemical analysis to the extract of *tethonia diversifolia*

3.2.1 Test for Steroids

3.2.2 Test for Saponins

3.2.3 Test for Terpenoids

3.2.4 Test for Quinones

3.2.5 Test for Tannins

3.2.6 Test for Phenolic compounds

3.2.7 Test for Flavoids

3.2.8 Test for Alkaloids

3.3 Evaluation of antibacterial activity

3.3.1 Selection of Bacterial species

3.3.2 Inoculation of Test Plates

3.4 Evaluation of toxicity

3.4.1 Preparation of Samples

3.4.2 Procedure

3.5 Preparation of fabric

3.5.1 De-sizing woven fabric

3.6 Finishing process

3.6.1 Soaking method

3.6.2 Boiling method

3.7 Optimization procedure for mosquito repellent finish

3.8 Objective Evaluation

3.8.1 Fabric weight

3.8.2Fabric thickness

3.8.3 Fabric stiffness

3.8.4 Tensile strength and elongation

3.8.5 Fabric wicking and sinking test

3.1 Selection of Source

In the present study, *Tethonia diversifolia* leaf was selected as the natural source and the common name is Mexican Sunflower. *Tethonia diversifolia* are well known for sesquiterpene lactones and diterpenoids – some of which have biological activities against insects. It has a repellent activity on the mosquito *Anapholes gambiae,* and a smaller, but still significant, action on other species of mosquito. Its reported activities as anti-inflammatory, analgesic, antimalarial, antiviral, antidiabetic, antidiarrhoeal, antimicrobial, antispasmodic, vasorelaxant and cancer-chemopreventive. (Kandungu.,2013) Based on the literature, Mexican Sunflower was selected as the mosquito repellent agent for the present study.

3.1.1 Plant Authentication

The plant specimen given by you for authentication is identified as *Thithonia Divesifolia* (Hemsl.) A.Gray (= *Miasolia Diversifolia* Hemsl.) – **ASTERACEAE.** From Tamil Naidu Agricultural university (TNAU), Coimbatore.

3.1.2 Preparation of extract from the selected source

For extraction 3kg of fresh leaves was ground using mixer grinder without adding water. The extract was filtered using grey fabric. About 2.5 liters of extract was in an airtight container. After this process the aqueous extract is ready to be used in antibacterial activity and mosquito repellent activity.

3.2 Phytochemical Analysis

Phytochemicals are responsible for the medicinal activity of the plant. These are non-nutritive chemicals that have protected human from various diseases. The major constituent consist of alkaloids, flavonoids, saponins, phenolic compounds. phytosterols, proteins and amino acids. The different extracts were subjected to the phytochemical evaluation. From C.N.R. Rao research centre, Avinashilingam Institute for Home Science Higher Education for Women, Coimbatore.

3.2.1 Test for Steroids

2 ml of the extract was taken in a test tube. 2 ml of chloroform was poured into the extract and then 5 ml of the sulphuric acid was added at the sides of the test tubes. There was a colour change which appeared on the extract. When the upper layer becomes red and later it turns into yellow colour it indicating the presence of steroids.

3.2.2 Test for Saponins

2 ml of the extract was taken in a test tube and later 6 ml of distilled water was poured in it. The presence of foam indicates the presence of saponins.

3.2.3 Test for Terpenoids

2 ml of extract was taken in a test tube and 2 ml of acetic anhydride was added to the extract. There is a formation of blue, green or red colour this indicates the presence of Terpenoids.

3.2.4 Test for Quinones

1 ml of the extract was taken in a test tube and 2 ml of dilute NaOH was added to it. The colour changes into blue, green and red color which indicates the presence of quinones.

3.2.5 Test for Tannins

2 ml of the extract was taken in a test tube and 10% of alcoholic ferric chloride solution was added to it. There is an appearance of blue greenish colour which indicates the presence of tannins.

3.2.6 Test for Phenolic compounds

2 ml of the extract was taken in a test tube. 5% of aqueous ferric chloride was added to it. If the colour changes into blue greenish colour which indicates the presence of Phenolic compounds.

3.2.7 Test for Flavoids

2 ml of the extract was taken in test tube. 1 ml of sodium hydroxide solution was added to it the colour changes into intense yellow colour which indicates the presence of flavoids.

3.2.8 Test for Alkaloids

2 ml of the extract was taken in the test tube and 2 ml of mayers reagent was added to it. There is an appearance of white creamy colour. It indicates the presence of Alkaloids.

TABLE – I

PHYTOCHEMICAL ANALYSIS

S. No.	Metabolite	Test performed	Observation
1.	Alkaloids	+ Mayer's reagent	Absence of Cream coloured precipitate
		+ Dragendorff'sreagent	Presence of reddish brown precipitate
2.	Flavonoids	Alkaline test	No change
		+ H_2SO_4	Absence of reddish orange colour
		+ lead acetate	Absence of white precipitate
		Shinoda test	Absence of crimson pink colour
3.	Sterols (Libermanntest)	+ $CHCl_3$+ Acetic anhydride +Conc.H_2SO_4	Presence of reddish brown ring
4.	Terpenoids (Libermann test)	+ $CHCl_3$+ Acetic anhydride + Conc. H_2SO_4	Absence of greencolour

5.	Anthraquinone (Borntrager'stest)	+ $FeCl_3$ + Conc. HCl + diethyl ether + Ammonia	Presence of reddishorange colour
6.	Anthocyanin	HCl Test	No Colour change
7.	Proteins	+ 2% Ninhydrinreagent	Absence of Purple colour
		+ 2% $CuSO_4$ + 95% ethanol +KOH pellet	Absence of blue colour
		+ conc. HNO_3	Presence of Yellow colouration
8.	Phenolic compounds	+ 5% neutral $FeCl_3$	Absence of bluish green coloured solution
		Gelatin test	Absence of whiteprecipitate
		+ Ellagic acid test	Absence of niggerbrown precipitate
9.	Quinones	Conc. HCl	Absence of yellow precipitate
		Alcoholic KOH	Absence of reddish solution
10.	Carbohydrates	Molisch's test	Presence of violet ring
		Fehling's test	Presence of red precipitate
11.	Tannin	Braymer's test	Absence of bluish green colour
		+ Gelatin test	Absence of white precipitate
		10% NaOH test	Absence of emulsion
12.	Saponins	Shaken with water	Presence of foam

13.	Cardiac glycosides	+ Baljet reagent	Absence of yellow orange colour
		Bromine water test	Absence of yellow precipitate
		Keller-killani test	Absence of brown ring
14.	Glycoside'stest	Borntrager's test	Absence of pink coloured solution
		Aq. NaOH test	Absence of yellow coloured solution
15.	Lignin	+ Gallic acid	Absence of olive-green colour
16.	Coumarins	Fluorescence test	No yellow fluorescence
		+ 10% NaOH + $CHCl_3$	Absence of yellow colour
17.	Volatile oils	Fluorescence test	No appearance of pinkish fluorescence

(- indicated absent, + indicated present)

3.3 Evaluation of antibacterial activity

The extract sample were subjected to anti-bacterial assessment by agar diffusion Method in ARL, Avinashilingam Institute for Home Science Higher Education for Women.

- 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 10^8 CFU/ml for *E.coli and Staphylococccus aureus.*

3.3.2 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° 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 50µl 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.

3.3.3 Selection of Bacterial species

Escherichia coli also known as *E.coli* is a gram negative, facultative anaerobic, rod shaped, coliform bacterium that is commonly on the lower intestine of the warm blooded organisms. It is versatile host for the production of heterologous proteins. Hence *E.coli* was selected as the representation of gram negative bacteria. *Bacillus subtilis* is a Gram positive bacteria found in soil and the gastrointestinal tract of ruminants and humans. Due to its excellent fermentation properties, with high product yield it is used to produce various enzymes, such as amylase and proteases. Hence *bacillus subtilis* was selected as the representation of gram positive bacteria.

3.4 Evaluation of Toxicity

3.4.1 Preparation of Samples

The given sample (MS) is diluted with distilled water to get 1% stock solution. The samples (MS) of different volume 100, 250, 500, 1000, 1500µl are added to each beaker containing salinesolution respectively.

3.4.2 Procedure

- 30 shrimps : 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.

3.5 Preparation of fabric

The cotton fabric have been commonly used as the fabric for herbal textile as it absorbs perspiration quickly, thus allowing the material to be fine and dry (Sekri, 2011). Weaving is a major fabric construction method. Weaving is an art of forming a fabric by interlacing two or more set of yarns at right angle. Weaving can be carried out in hand loom or power loom. And the plain weave is the simplest and most inexpensive weave (Somasekar, 2003).

Spunlace non-woven are used in common objects such as wet wipes, facial mask fabrics, and medical non-woven fabrics, just to name a few. To make a spunlace non-woven, high-pressure water jets are applied to one or more layers of fiber web, and the water pushes the fibers into a lace-like pattern. This non-woven composition is strong due to the irregularity of the fibre interlay. It is valued for its high absorbency rate.

Cotton fabric can control and cure various diseases without causing any side effects when combined with herbal extract and close contact with skin (Mary, 2008). The investigator selected 100% plain woven fabric for the study. (Annexure – i)

3.5.1 Desizing woven fabric

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.

Recipe:

ML Ratio: 1:30

Soap nut extract -10%

Extract of ash water – 10%

Temperature – 100° C

Time – 1hr

3.6 Finishing process

3.6.1 Soaking method (dip and dry)

Extraction solution was taken in 100% concentration and 50% concentration water was added. The de-sized cotton fabric was dipped into the extraction solution for 30 minutes in two different concentration individually. After that the dipped fabric was taken out and dried in the shade. This is carried out for both woven and non-woven fabric.

3.6.2 Boiling method

Extraction solution was taken in 100% concentration and 50% concentration water was added. The de-sized woven cotton fabric was soaked in the concoction and boiled for 30mins at 60^{O}C. Constant stirring was done from time to time to have good absorbency and also to have even finish with extract solution. Then the finished cloth was allowed to cool and dried in shade. This is carried out for woven cotton fabric only.

3.7 optimization procedure for multifunctional finishing

The optimization of standard condition for mosquito repellent 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.

3.7.1 Determination of optimum concentration for finish on fabric

The fabric was treated with two different concentration of *Tethonia diversifolia* 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.

3.7.2 Determination of optimum time for finish on fabric

The multifunctional finish of cotton woven and nonwoven fabric treated with the extract of *Tethonia diversifolia* 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

3.7.3 Determination of optimum temperature for finish on fabric

For dip and dry method with two different concentration with two different time in room temperature. For boiling method with two different concentration with two different time in 50 degree Celsius and 100 degree Celsius.

Concentration: 100 extract and 50 extract

Time: 24 hrs and 30mins

Temperature: Room temperature and 50 degree Celsius

Finishing method: Dip and Dry method and boiling method

3.8 Optimization procedure for mosquito repellence

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

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 – CULTURING OF MOSQUITO LARVA

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 – INTRODUCING TEST MATERIAL INTO THE CAGE

The Mexican sunflower leaf (*tithonica diversifolia)* were extracted by aqueous method. These extract at different concentration namely 50% and 100% were treated on woven and non-woven cotton fabric. Fabrics have been given finish using soaking and boiling method using the aqueous extract. So including untreated fabric totally 8 samples have been introduced to the mosquito cage on 23.02.2023 at 12:30 pm. The larval activity were observed after keeping fabric inside the mosquito cage. Slowly larval activity were decreased due to active compound present in the *Mexican sunflower* leaf extract.

PHASE – 3 – OBESRVING THE LARVA MOMENT

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 Mexican sunflower. The larval and pupal activity were slow.

PHASE – 4 – ACTIVITY OF LARVA

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

PHASE – 5 – DEVELOPMENT OF ADULT MOSQUITTO

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 Mexican sunflower.

PHASE – 6 – SUMMURY OF CAGE-1

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 – CULTURING OF MOSQUITO LARVA

The mosquito larval were 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 – LARVA TO PUPA STAGE

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 were not introduced to cage at this stage.

PHASE – 3 – FOOD FEEDING TO THE LARVA AND PUPA

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

PHASE – 4 – INTRODUCING TEST MATERIAL INTO THE CAGE

The Mexican sunflower leaf (*tithonica diversifolia*) were extracted by aqueous method. These extract at different concentration as 50% and 100% were treated on woven and non-woven cotton fabric. Fabrics have been given finish using soaking 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 waws also started getting slow down.

PHASE – 5 – OBSERVING THE MOVEMENT OF ADULT MOSQUITO

After 24hrs on 28.02.2023, activity of adults, pupal and larva was decreased simultaneously. Because of the attraction of treated fabric. Dew to this few adults were found dead also.

PHASE – 6 – FOUNDING OF DEAD ADULTS

Few adults around 10 were dead, pupal and larval growth of few get slowed and some pupal and larval activity decreased completely.

PHASE – 7 – CONCLUDING THE RESULT

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.

3.9 Objective analysis

Evaluation is defined as the making of judgment about the value for some purpose, ideas, works, solutions and materials. The properties of the fabric are directly influenced the end product. Hence it is necessary to evaluate fabric for an effective end use.

3.9.1 Fabric weight

Fabric weight is the relative weight of the fabric and is the weight of a particular size of piece in grams per square meter or ounces per square yard (Chilukoti, 2012).

Fabric was cut using a GSM Cutter (plate 16) and Electronic Weighing alance was used to find out the weight of the samples. The inference obtained is calculated using the formula:

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

Weight of the fabric = x g

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

Area of square = length x breadth Square unit

The same procedure was followed to find out the fabric weight of original and finished fabrics were carefully recorded and the mean value was calculated.

3.9.2Fabric thickness

Fabric Thickness is defined as the distance between lower and upper surface of the material measured under a standard pressure, using Shirley Thickness Tester (plate 17) with an accuracy of 0.01 mm. Fabric thickness gauge are used to measure thickness of the sample. It has two parts of anvil and pressure foot. Pressure was given at the foot to make the gauge zero. The samples was placed between the cleaned pressure foot and anvil. The reading shown by the dial was noted. For each samples at five different places away from two inches of the selvedge.

3.9.3 Fabric stiffness

This test measures the bending stiffness of a fabric by allowing a narrow strip of the fabric to bend to a fixed angle under its own weight. The length of the fabric required to bend to this angle is measured and is known as the bending length. The test specimens are each 25mm wide and 200mm long, 3 are cut parallel to the warp and 3 parallel to the weft so that no two warp specimens contain the same warp threads, and no two weft specimens contain the same weft threads. The specimens should not be creased and those that tend to twist should be flattened. Before the test the specimens are preconditioned. Four readings are taken from each specimen, one face up and one face down on the first end and then the same for the second end. The mean bending length for warp and weft is calculated. The higher the bending length, the stiffer is the fabric.

3.9.4 Tensile strength and elongation

The British standard for fabric tensile strength involves extending a strip of fabric to its breaking point by a suitable mechanical means which can record the breaking load and extension. Breaking strength is a measure of resistance of the fabric to tensile load in a warp or weft direction (Saville, 2000). The Eureka model Tensile Strength Tester (plate 19) was used for the study. Five fabric samples were extended in a direction parallel to the warp and five parallel to the weft, no two samples to contain the same longitudinal threads. The specimens were cut to a size of 60mm x 30mm and then frayed down in the width equally at both sides to gives samples which were exactly 50mm wide. This ensures that all the threads run the full length of the sample so contributing to the strength and also that the width was accurate. The rate of extension was set to 50mm/min. and the distance between the jaws was set to 200mm. The sample was pretensioned to 1% of the probable breaking load. Any breaks that occur 5mm of the jaws were rejected and also those at loads substantially less than the average. The mean breaking force and mean extension as a percentage of initial length were recorded for original and finished samples.

3.9 .5 Fabric wicking and sinking test

The wicking test was conducted as per the procedure as per the procedure. A strip of fabric (30 cm x 2cm) was suspended vertically with an edge in reservoir of distilled was then moisture. To detect the position of water line a days was added to the water ability to absorb water. water was The sinking test is a sample test that helps to measure the wet ability of the fabric about to sample were cut into a small square specimen about 1×1 is at the cheap. The surface is absorbed the time is greater than the wet ability.

3.10 Nomenclature

TABLE - II

S.NO	FABRIC DETAILS	NOMENCLATURE
1	Non-woven cotton original	NWC
2	Non-woven concentration 50	NW50
3	Non-woven concentration 100	NW100
4	Woven cotton original	WC
5	Woven soaking method concentration 50	WCS50
6	Woven soaking method concentration 100	WCS100
7	Woven boiling method concentration 50	WCB50
8	Woven boiling method concentration 100	WCB100

LIST OF PLATE

PLATE 1

MEXICAN SUNFLOWER PLANT

PLATE 2

MEXICAN SUNFLOWER LEAF

PLATE 3

MEXICAN SUNFLOWER LEAF EXTRACT

PLATE 4

BOILING METHOD OF EXTRACTION AND

FINISHING OF WOVEN FABRIC

PLATE 5

FINISHING OF FABRIC USING FRESH EXTRAT

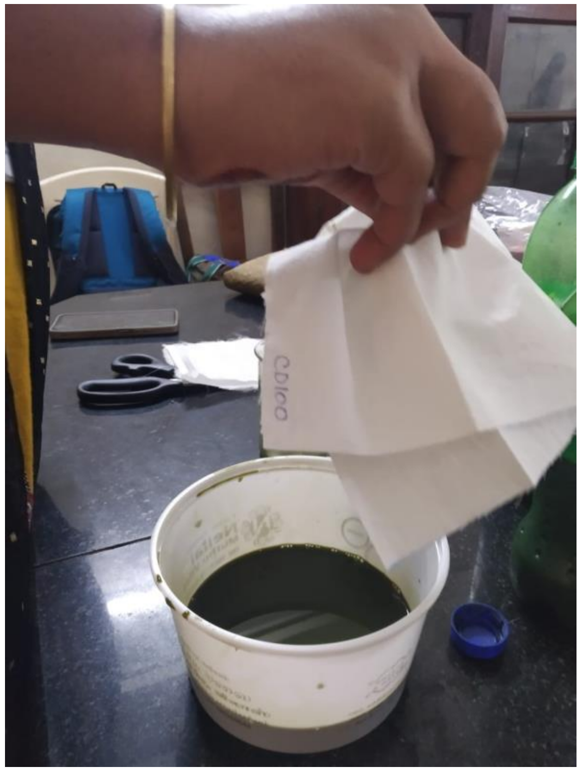


PLATE 6

DIP AND DRY METHOD OF FINISHING NONWOVEN

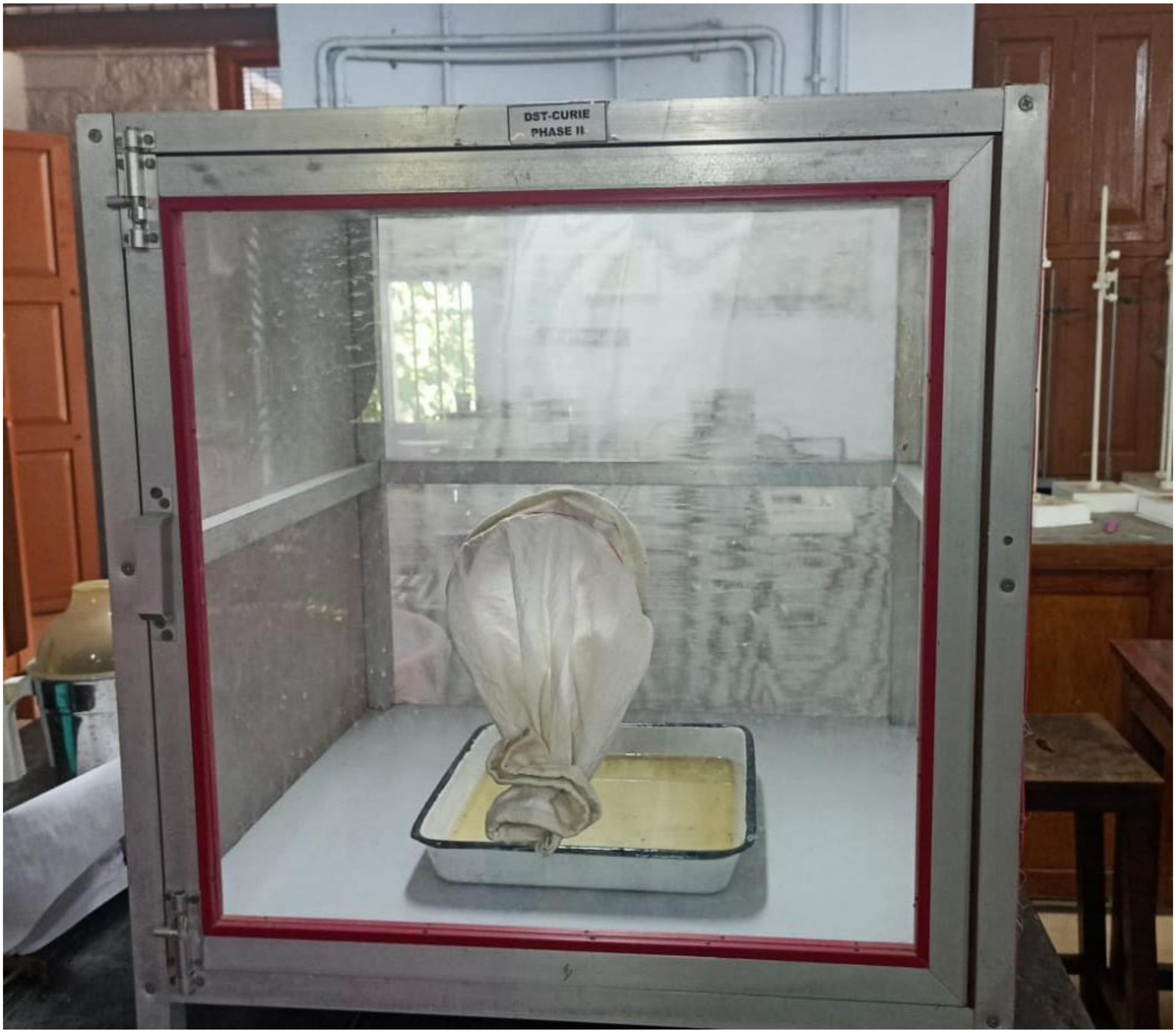


PLATE 7

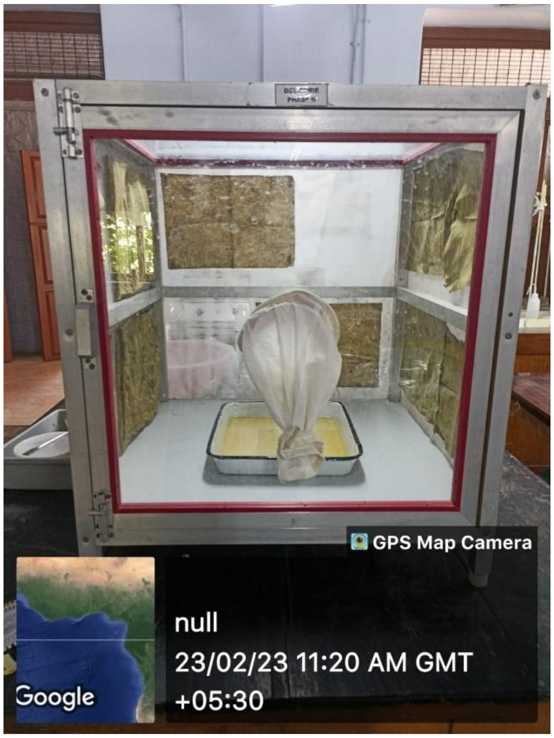
MOSQUITO CAGE SETUP

PLATE 8

MOSQUITO REPELLENT TEST – PLACING LARVAL IN TRAY

PLATE 9

MOSQUITO REPELLENT TEST - FEEDING LARVA



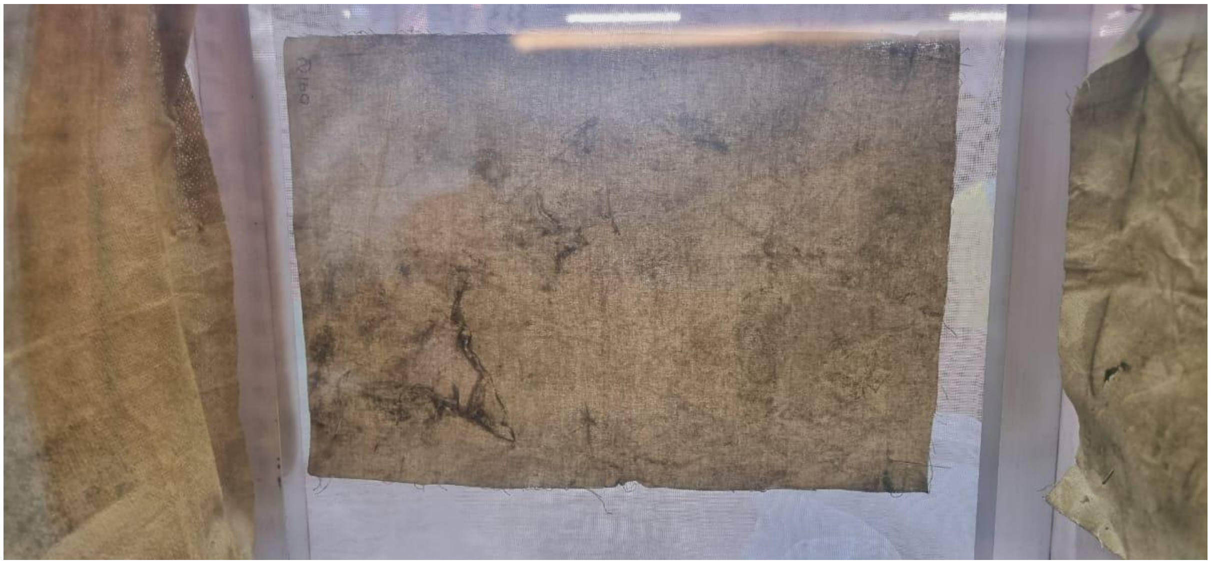


PLATE 10

TEST SAMPLE PLACED IN MOSQUITO CAGE

PLATE 11

DEAD MOSQUITO IN CAGE

4. RESULT AND DISCUSSION

The **result and discussion** pertaining to the study "**Anti-Bacterial and Mosquito Repellent Efficiency of Woven and Nonwoven fabrics treated with Mexican Sunflower Leaf extract"** consist of following headlines

4.1 Phytochemical test

4.2 Antibacterial test

4.3 Toxicity test

4.4 Objective evaluation

4.4.1 Fabric weight

4.4.2 Fabric stiffness - warp

4.4.3 Fabric stiffness – weft

4.4.4 Fabric thickness

4.4.5 Tensile strength – warp

4.4.6 Tensile strength – weft

4.4.7 Fabric elongation – warp

4.4.8 Fabric elongation – weft

4.4.9 Fabric abrasion

4.5 wetablity test

4.5.1 Fabric wicking test

4.5.2 Fabric sinking test

4.6 Mosquito repellence test

4. RESULT AND DISCUSSION

4.1 Phytochemical screening

Phytochemical screening of Mexican sunflower (*Tithonica Diversifolia*) leaf extract was done in methanol extract, Tannin, quinine, terpenoid, flavonoid, steroid, alkaloid, cardiac glycoside, glycoside, volatile oils, etc were the phytoconstituents found in plants. The study of the effect of phytoconstituents in the Mexican sunflower (tithonica diversifolia) revealed that the phytoconstituents present in plant extracts showed the presence of antimicrobes and antibacterial i.e. in Mexican sunflower leaf (tithonica diversifolia). The phytoconstituents present in the plant extract showed an effect on cell proliferation and growth. Hence this plant could be used to develop drugs against microbes and bacteria. The results pertaining to phytochemical screening is given in (Table - III).

TABLE – III

PHYTOCHEMICAL SCREENING

s.no	METABOLITE	RESULT
1	Alkaloids	+
2	Flavonoids	-
3	Sterols	+
4	Terpenoids	-
5	Anthraquinone	+
6	Anthicyanin	-

7	Proteins	+
8	Phenolic compounds	-
9	Volatile oils	-
10	Quinones	-
12	Carbohydrate	+
13	Tannin	-
14	Saponins	+
15	Cardiac glycosides	-
16	Glycosides test	-
17	Lignin	-
18	coumarins	-

(- indicated absent, + indicated present)

From the table-III it is clear that the extraction of leaf contains Alkaloids, Sterols, Anthraquinone, Proteins, Carbohydrates and saponins were detected in leaf extraction from aqueous method.

4.2 Antimicrobial test

Extract of leaf is treated with two different bacteria namely ***Staphylococcus aureus*** and ***E.coli*** it has good result when treated with ***E.coli*** has 17mm and the extract has 15mm, as shown in table IV**.**

TABLE IV

ANTIMICROBIAL TEST

Sample	**Zone of Inhibition (mm)**	
	Staphylococcus aureus	***E.coli***
Standard (Rifampicin)	35mm	17mm
Negative control (Water)	0mm	0mm
MS	18mm	16mm

From the Table IV, it is evident that *Tithonica Diversifolia* leaf extract shows Antibacterial activity against both extract of leaf is treated with two different bacteria namely *Staphylococcus aureus* and *E.coli* is on par with the commercial statement. Existence of Anti Bacterial activity due to the presence of alkaloids.

4.3 Toxicity test

The Mexican Sunflower leaf extract is comparatively not toxic than $K_2Cr_2O_7$ which shows maximum lethality of shrimps at higher concentration. The shrimps in the sample (ms) are found to be non-toxic in lower concentration as well as in higher concentration. Even after 24hrs, only 3 shrimps are found to be mortal at highest concentration as shown in Table V.

TABLE V

TOXICITY TEST

S. No	**Sample Code**	**Concentration (µg/ml)**	**Mortality of Brine shrimp(no. of shrimps dead) (h)**					
			1	**2**	**4**	**6**	**24**	**% Morality (at24h)**
1.	MS	100	0	0	0	0	1	3
		250	0	0	0	1	1	3
		500	0	0	0	0	1	3
		1000	0	0	0	0	1	3
		1500	0	0	0	1	1	3
2.	**Control $K_2Cr_2O_7$**	**1 (mg/ml)**	**30**	**-**	**-**	**-**	**-**	**100**
3.	**Blank**	**Saline water**	0	0	0	0	0	0

N= 3

4.4 Objective evaluaion

4.4.1 Fabric weight

The fabric weight and analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table VI and Figure 1.

TABLE VI

FABRIC WEIGHT

S.NO	SAMPLE	MEAN FABRIC WEIGHT (GSM)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	NWC	0.370	-	-	6.86	0.008*
2	NW50	0.390	0.02	1.5		
3	NW100	0.410	0.04	3.17		
4	WC	1.060	-	-	4.63	0.006*
5	WCS50	1.100	0.04	3.17		
6	WCS100	1.110	0.05	3.96		
7	WCB50	1.130	0.07	5.5		
8	WCB100	1.260	0.2	15.87		

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

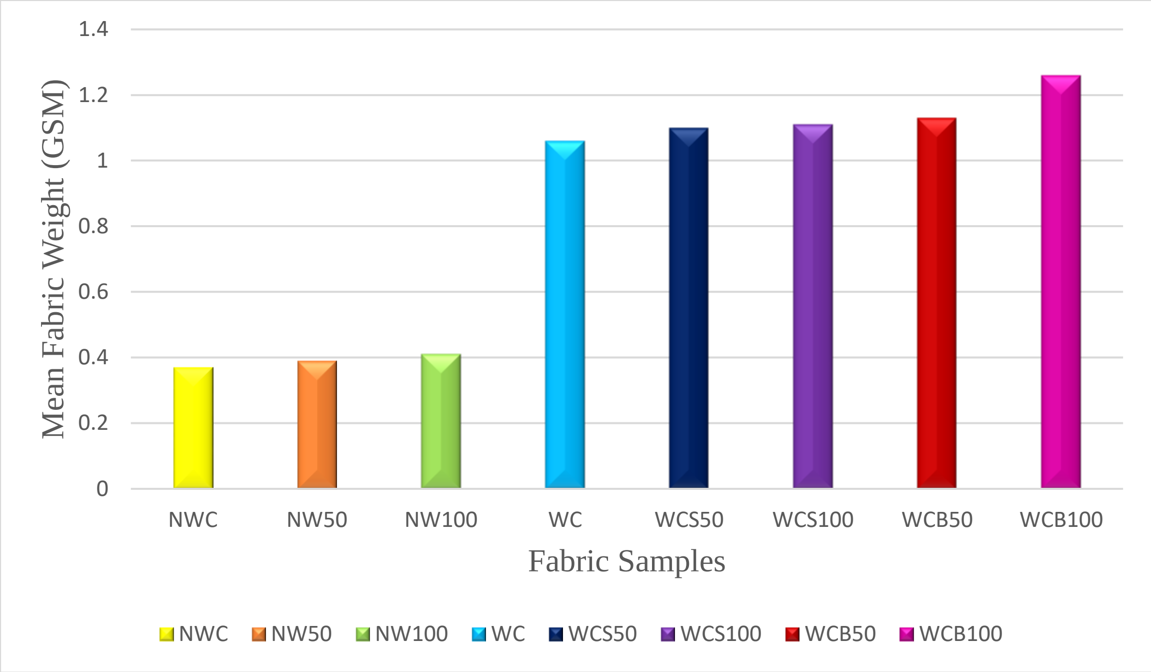


FIGURE 1

FABRIC WEIGHT

From the Table VI it is clear that the fabric weight of the treated samples NW50, NW100, WCS50, WCS100, WCB50 andWCB100 has increased after treatment. The maximum weight was occurred in WCB100 sample. Hence it could be concluded that after treatment the weight of the fabric increased gradually in all samples.

4.4.2 Fabric stiffness warp

The fabric stiffness along warp direction and analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table VII and Figure 2.

TABLE VII

FABRIC STIFFNESS WARP

S.NO	SAMPLE	MEAN STIFFNESS In (Degree)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	NWC	1.7	-	-	6	0.012*
2	NW50	1.9	0.2	6.8		
3	NW100	2.1	0.4	13.7		
4	WC	2.4	-	-	3.14	0.018*
5	WCS50	2.9	0.5	17.2		
6	WCS100	2.8	0.4	13.7		
7	WCB50	2.7	0.3	10.3		
8	WCB100	2.6	0.2	6.8		

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

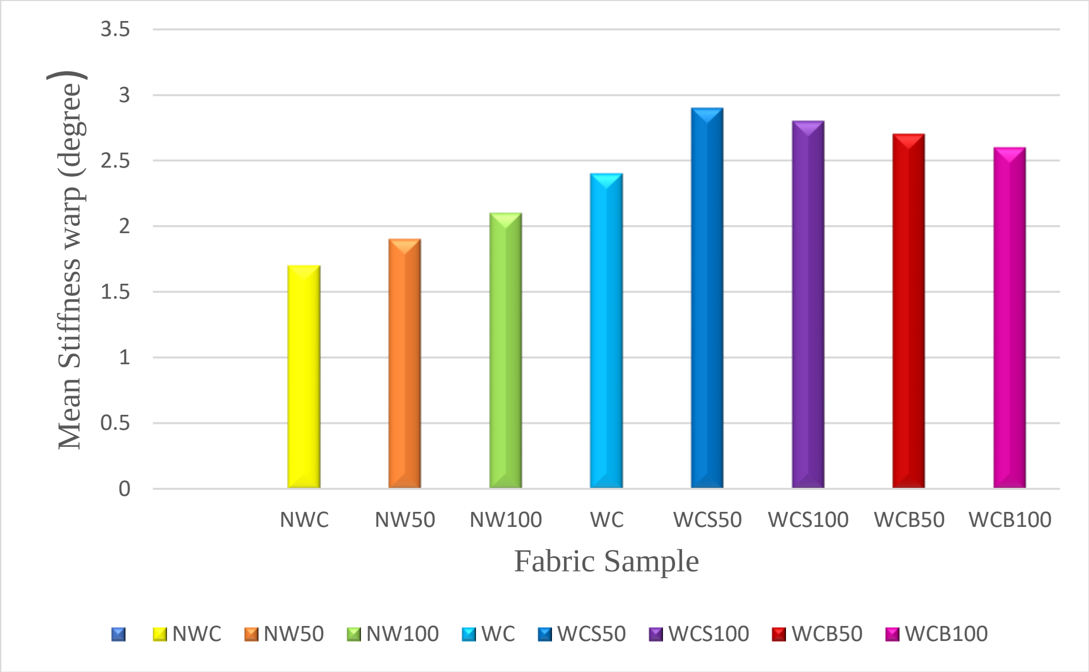


FIGURE 2

FABRIC STIFFNESS WARP

4.4.3 Fabric stiffness weft

The fabric stiffness by weft and analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table 8 and Figure 3.

TABLE VIII

FABRIC STIFFNESS WEFT

S.NO	SAMPLE	MEAN STIFFNESS In (Degree)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	NWC	1.5	-	-	6	0.012
2	NW50	1.7	0.2	7.1		
3	NW100	1.9	0.4	14.2		
4	WC	1.9	-	-	3.14	0.018*
5	WCS50	2.8	0.9	32.1		
6	WCS100	2.7	0.8	28.5		
7	WCB50	2.1	0.2	7.1		
8	WCB100	2.2	0.3	10.7		

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

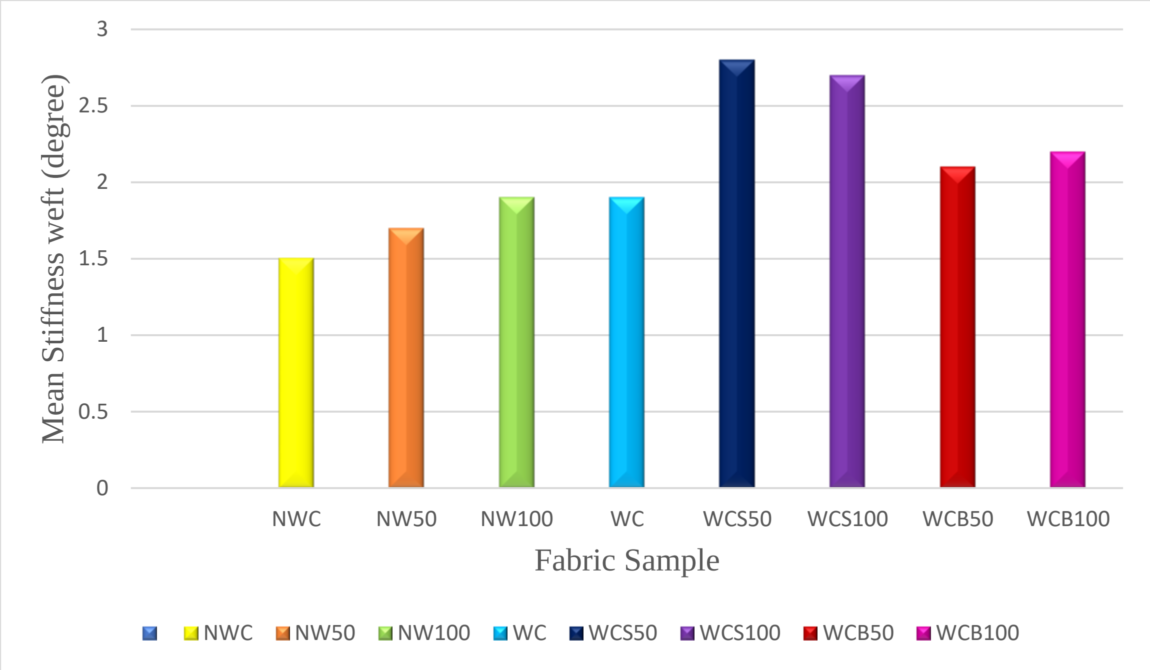


FIGURE 3

FABRIC STIFFNESS WEFT

From the Table VIII it is clear that the maximum stiffness was occurred in WCB100 sample. The fabric stiffness of the sample NWC and WC lower than the treated sample NW50,NW100,WCS50,WCS100,WCB50 andWCB100 for both warp and weft respectively. Hence it could be concluded that after treatment the stiffness of the fabric increased gradually in all samples.

4.4.4 Fabric thickness

The fabric thickness and analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table IX and Figure 4.

TABLE IX

FABRIC THICKNESS

S.NO	SAMPLE	MEAN THICKNESS In (mm)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	NWC	28.3	-	-	4.92	0.023*
2	NW50	31.6	3.3	10.4		
3	NW100	29.4	1.1	3.4		
4	WC	23.2	-	-	4.38	0.008*
5	WCS50	25.2	2	6.3		
6	WCS100	24.6	1.4	4.4		
7	WCB50	26	2.8	8.8		
8	WCB100	28.8	5.6	17.7		

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

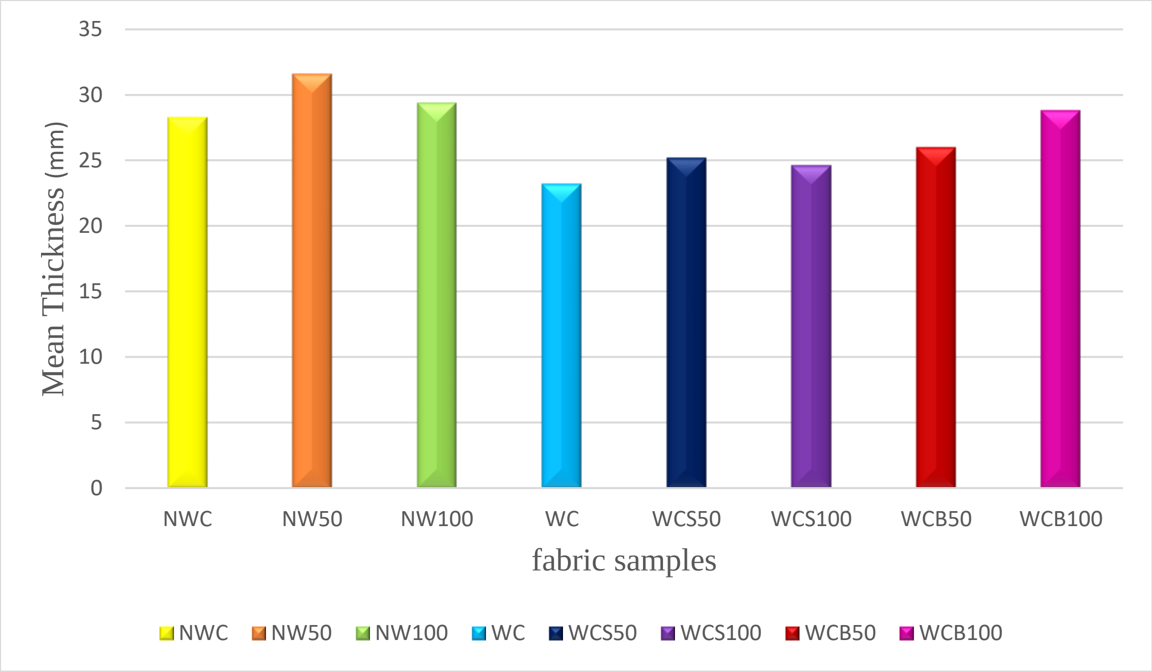


FIGURE 4

FABRIC THICKNESS

- From the Table IX it is clear that the fabric thickness of the sample NWC and WC was 28.3mm and 25.2mm. fabric thickness of the sample NW50, NW100, WCS50, WCS100, WCB50 and WCB100 is measured as 31.6mm,29.4mm,23.2mm,24.6mm,26mm and 28.8mm respectively. The maximum stiffness was occurred in NW50 sample. Hence it could be concluded that after treatment the thickness of the fabric increased gradually in all samples.

4.4.5 Fabric strength warp

The fabric strength along warp direction analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table X and Figure 5.

TABLE X

FABRIC STRENGTH WARP

S.NO	SAMPLE	MEAN STRENGTH (kg)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	WC	19	-	-	5.39	0.003*
2	WCS50	25	6	23		
3	WCS100	26	7	26.9		
4	WCB50	20	1	3.8		
5	WCB100	21	2	7.6		

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

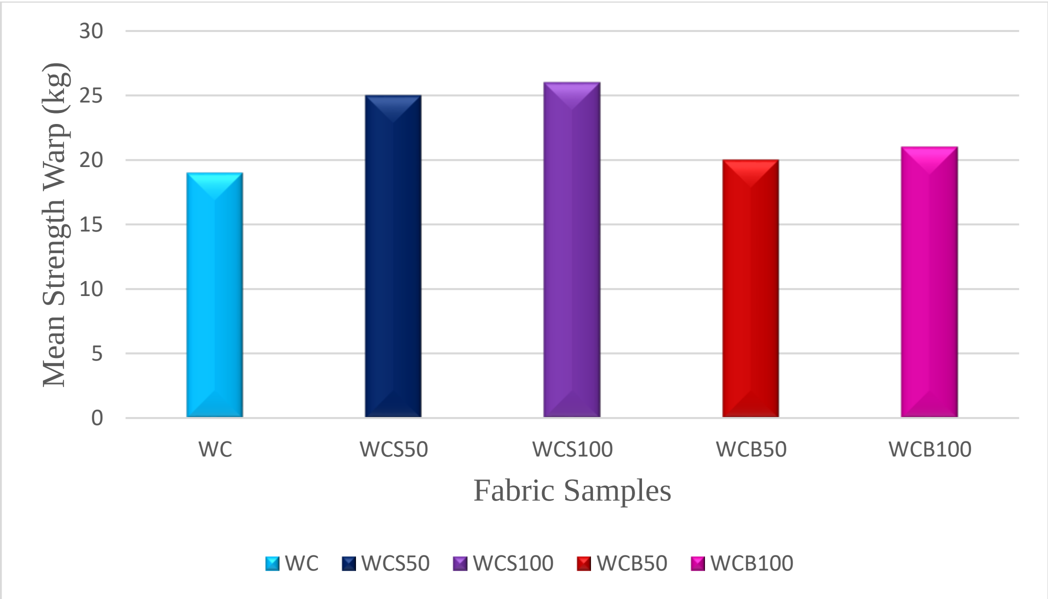


FIGURE 5

FABRIC STRENGTH WARP

4.5.6 Fabric strength weft

The fabric strength along weft direction analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table XI and Figure 6.

TABLE XI

FABRIC STRENGTH WEFT

S.NO	SAMPLE	MEAN STRENGTH (kg)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	WC	21	-	-	3.73	0.016*
2	WCS50	28	7	25		
3	WCS100	27	6	21.4		
4	WCB50	22	1	3.5		
5	WCB100	23	2	7.1		

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

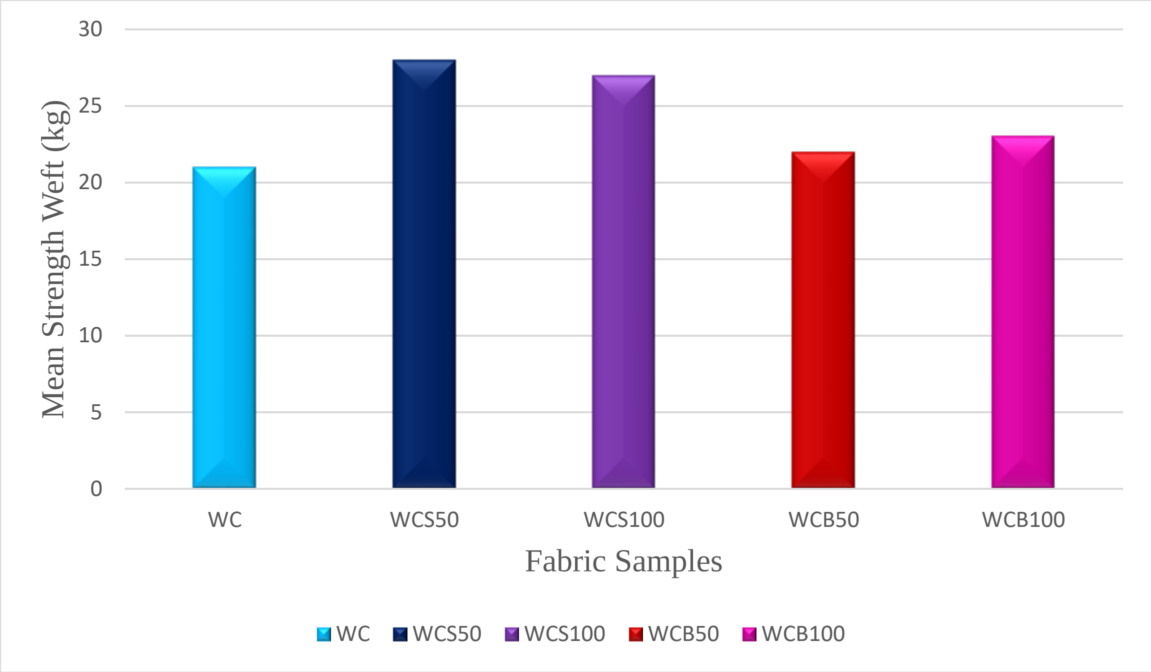


FIGURE 6

FABRIC STRENGTH WEFT

From the Table XI it is clear that the maximum strength was occurred in WCS50 sample. The fabric strength of the sample NWC and WC is lower than the treated sample NW50,NW100,WCS50,WCS100,WCB50 andWCB100 for both warp and weft respectively.. Hence it could be concluded that after treatment the strength of the fabric increased gradually in all samples.

4.5.7 Fabric elongation warp

The fabric elongation by warp and analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table XII and Figure 7.

TABLE XII

FABRIC ELONGATION WARP

S.NO	SAMPLE	MEAN ELONGATION (cm)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	WC	2.1	-	-	5.41	0.003*
2	WCS50	2.4	0.3	13		
3	WCS100	2.6	0.5	21.7		
4	WCB50	2.2	0.1	4.3		
5	WCB100	2.3	0.2	8.6		

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

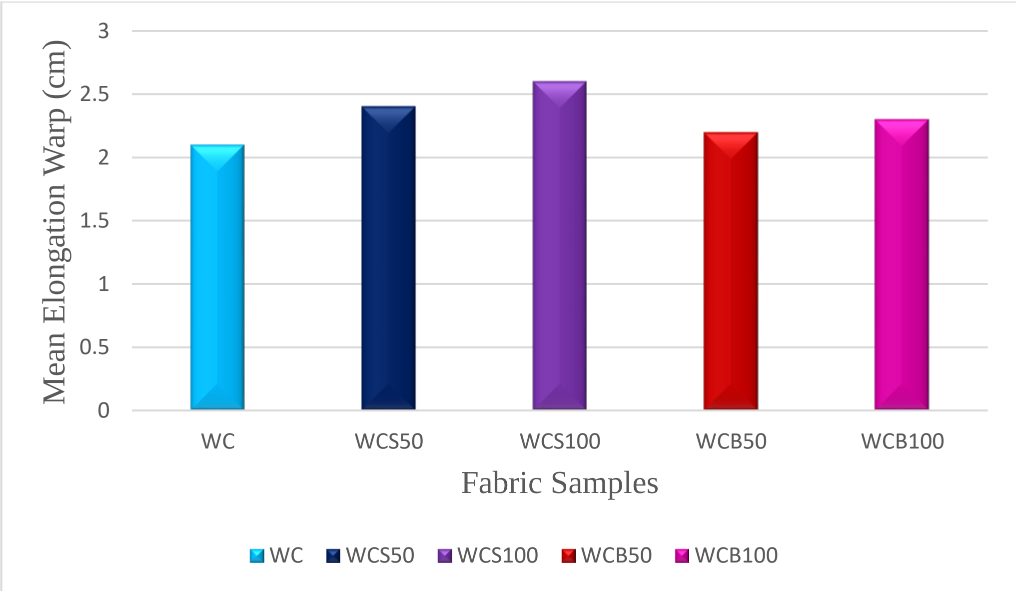


FIGURE 7

FABRIC ELONGATION WARP

4.5.8 Fabric elongation – weft

The fabric elongation along warp direction analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table XIII and Figure 8.

TABLE XIII

FABRIC ELONGATION WEFT

S.NO	SAMPLE	MEAN ELONGATION (cm)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	WC	2.5	-	-	4.28	0.009*
2	WCS50	3.0	0.5	16.6		
3	WCS100	2.9	0.4	13.3		
4	WCB50	2.6	0.1	3.3		
5	WCB100	2.7	0.2	6.6		

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

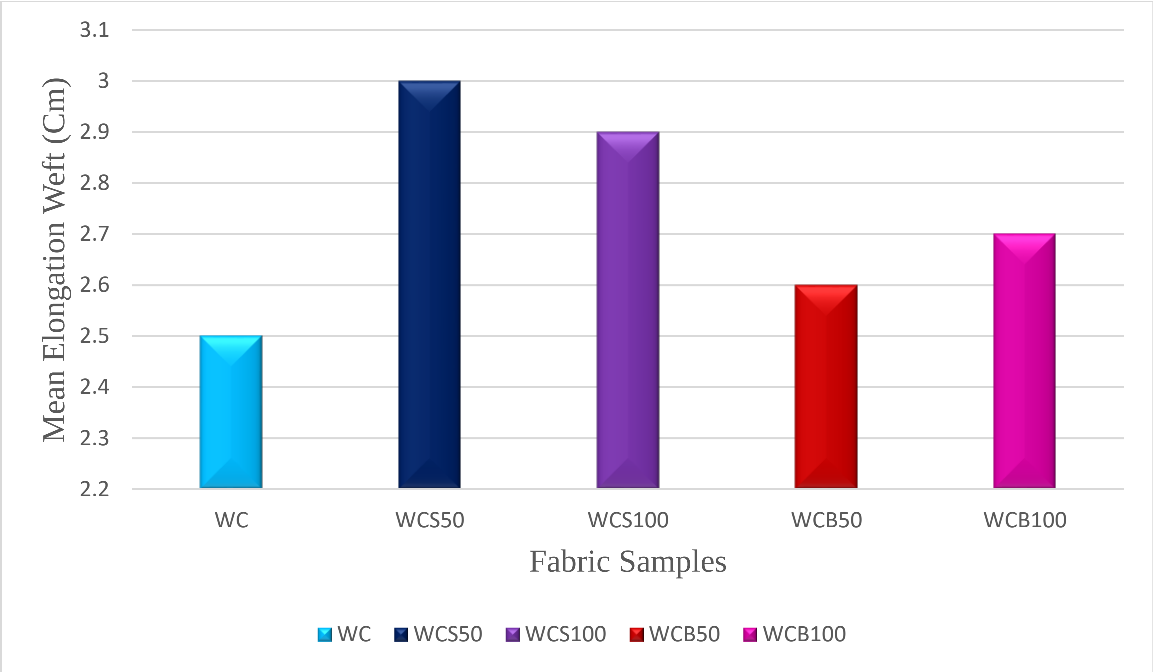


FIGURE 8

FABRIC ELONGATION WEFT

From the Table XII it is clear that the maximum elongation was occurred in WCS50 sample. The fabric elongation on both warp and weft of the sample NWC and WC lower than the treated sample NW50,NW100,WCS50,WCS100,WCB50 andWCB100 for both warp and weft respectively.. Hence it could be concluded that after treatment the elongation of the fabric increased gradually in all samples.

4.5.9 Fabric abrasion

The fabric abrasion and analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table XIV and Figure 9.

TABLE XIV

FABRIC ABRASION

S.NO	SAMPLE	MEAN ABRATION in (gms)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	NWC	12	-	-	10.33	0.003*
2	NW50	7	7	27		
3	NW100	7	3	27		
4	WC	15	-	-	5.69	0.002*
5	WCS50	11	5	45		
6	WCS100	13	5	45		
7	WCB50	10	3	27		
8	WCB100	12	4	36		

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

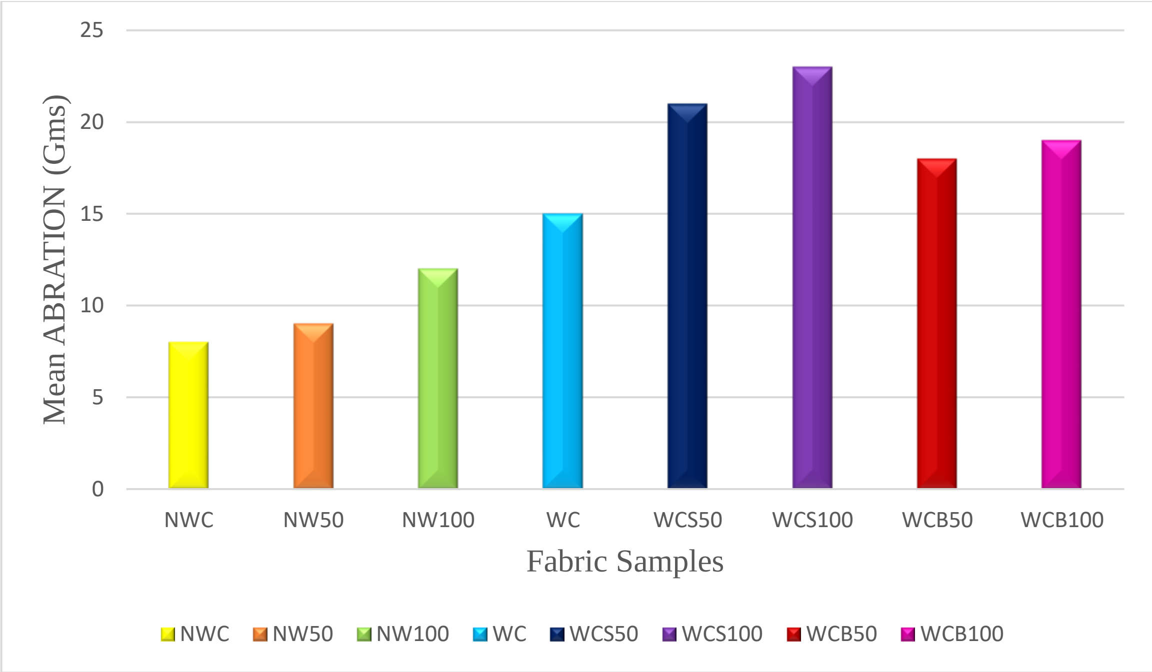


FIGURE 9

FABRIC ABRASION

From the Table XIV it is clear that the fabric abrasion of the sample NWC and WC lower than the treated sample NW50,NW100,WCS50,WCS100,WCB50 andWCB100 for both warp and weft respectively. The maximum abration was occurred in WCS100 sample. Hence it could be concluded that after treatment the abrassion of the fabric increased gradually in all samples.

4.5Wettablity test

4.5.1 Sinking test

The fabric sinking and analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table XIV and Figure 9.

TABLE XV

SINKING TEST

S.NO	SAMPLE	MEAN SINKING (sec)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	NWC	45	-	-	5.79	0.014*
2	NW50	51	6	11.7		
3	NW100	48	3	5.8		
4	WC	15	-	-	5.30	0.003*
5	WCS50	24	9	17.6		
6	WCS100	26	11	21.5		
7	WCB50	35	20	39.2		
8	WCB100	30	15	29.4		

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

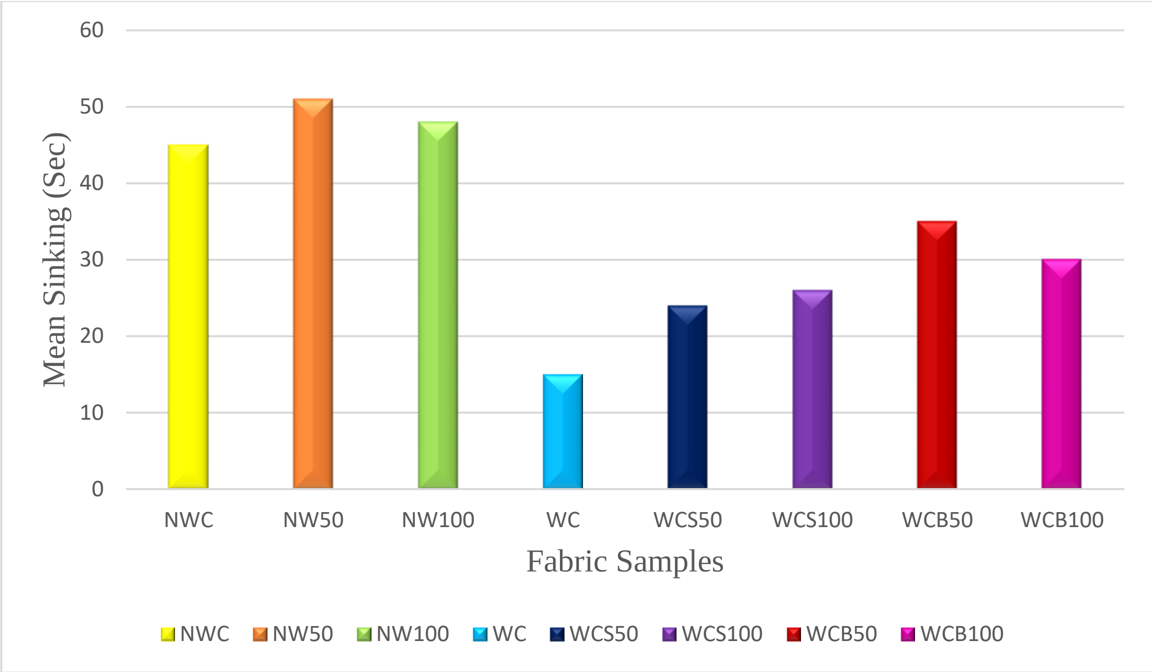


FIGURE 10

SINKING TEST

From the Table XV it is clear that the maximum sinking was occurred in NW50 sample. The fabric sinkage of the sample NWC and WC was 45sec and 15sec. Fabric thickness of the sample NW50,NW100,WCS50,WCS100,WCB50 andWCB100 is measured as 51sec, 48sec, 24sec, 26sec, 35sec and 30sec respectively. The maximum wickablity was in NW50 sample. Hence it could be concluded that after treatment the sinkage of the fabric is high in all samples.

4.5.2Wickablity test

The fabric wickablity and analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table XVI and Figure 10.

TABLE XVI

WICKABLITY TEST

S.NO	SAMPLE	MEAN WICKABLITY (cm)	LOSS (OR) GAIN OVER ORIGINAL	%LOSS OR GAIN OVER ORIGINAL	F - TEST	P VALUE
1	NWC	1.9	-	-		
2	NW50	2.4	0.5	18.5	4.08	0.038*
3	NW100	2.7	0.8	29.6		
4	WC	1.8	-	-		
5	WCS50	2.2	0.4	14.8		
6	WCS100	2.7	0.9	33.3	3.46	0.022*
7	WCB50	1.9	0.1	3.7		
8	WCB100	2.3	0.3	11.1		

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

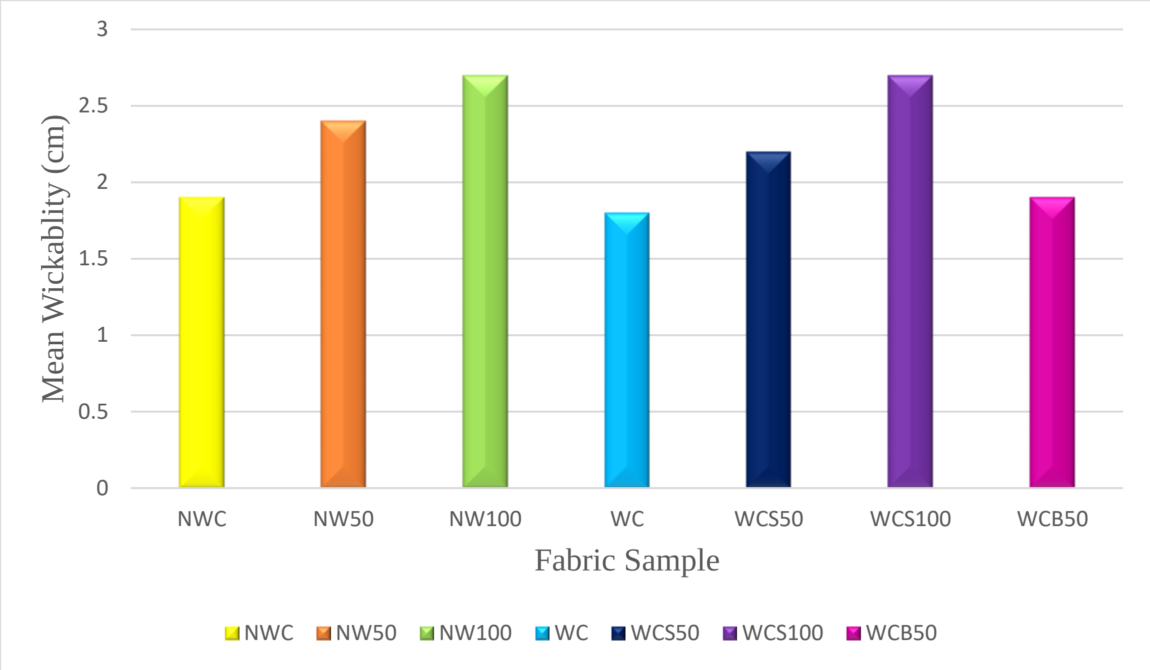


FIGURE 11

WICKABLITY TEST

From the Table XVI it is clear that the fabric wickablity of the treated sample has increased after treatment than the original NW50, NW100, WCS50, WCS100, WCB50 and WCB100 has increased while wickablity. The maximum wickablity was occurred in WCS100 sample. Hence it could be concluded that after treatment the wickablity of the fabric increased gradually in all samples.

4.6 Mosquito repellency test

The mosquito repellency behaviour of both woven and non-woven fabric samples was tested using mosquito cage test. Larva, pupas and mosquitoes were formed using hay infusion method. All the stages of mosquitoes were tested through the cage. The fabric repellency and analysis of variance of the sample NWC, NW50, NW100, WC, WCS50, WCS100, WCB50 and WCB100 are shown in Table XVII and   Figure 11.

TABLE – XVII

MOSQUITO REPELLENCY

S.NO	SAMPLE	MOSQUITO REPELLENCY (%)
1	NWC	**35**
2	NW50	**85**
3	NW100	**96**
4	WC	**28**
5	WCS50	**92**
6	WCS100	**98**
7	WCB50	**73**
8	WCB100	**74**

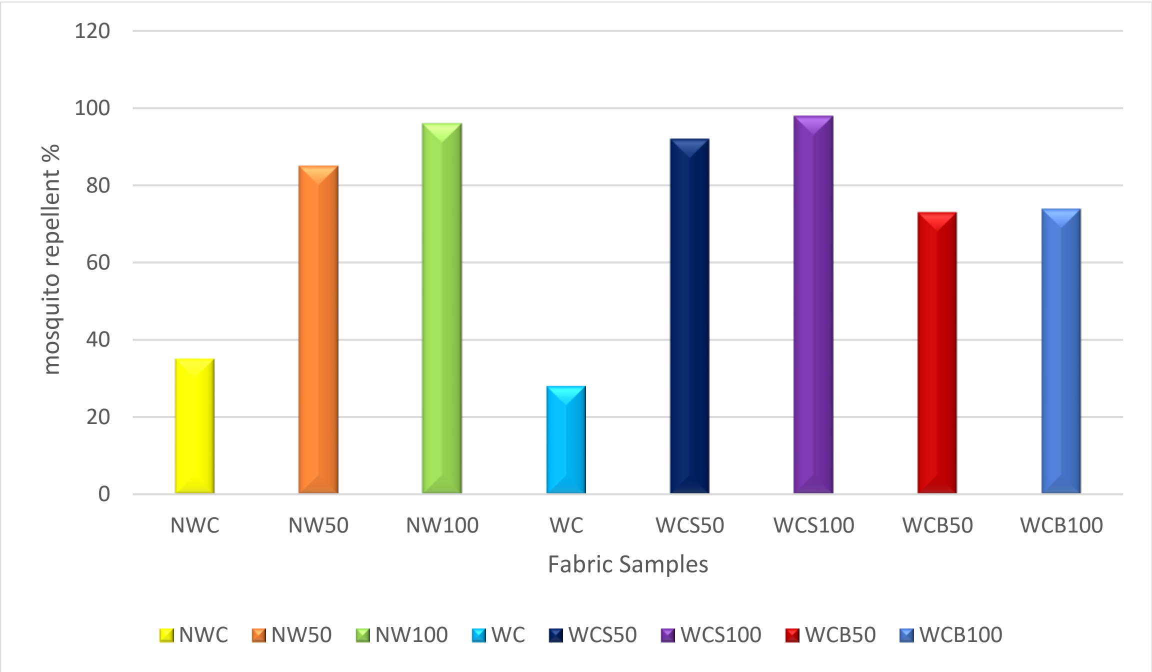


FIGURE – 12

MOSQUITO REPELLENCY TEST

From the Table XVII, it is understood that Mosquito repellency efficiency of finished fabrics NW50,NW100,WCS50,WCS100,WCB50 andWCB100 possess mosquito repellancy than untreated fabric NWC and WC. The maximum mosquito repellency was found to be good among 98, 96 and 92 as exhibited by WCS100, NW100 and WCS 50. It was followed by the samples MW50 (85%), WCB (74%) and WCB(73%). Hence it could be concluded that after treatment the mosquito repellent of the fabric is efficient.

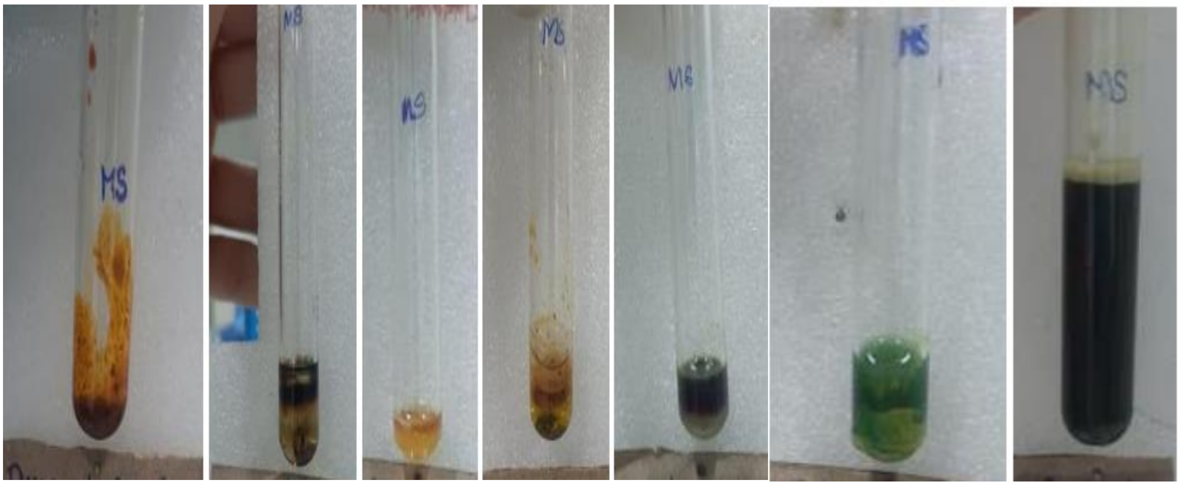


PLATE 12

PHYTOCHEMICAL TEST

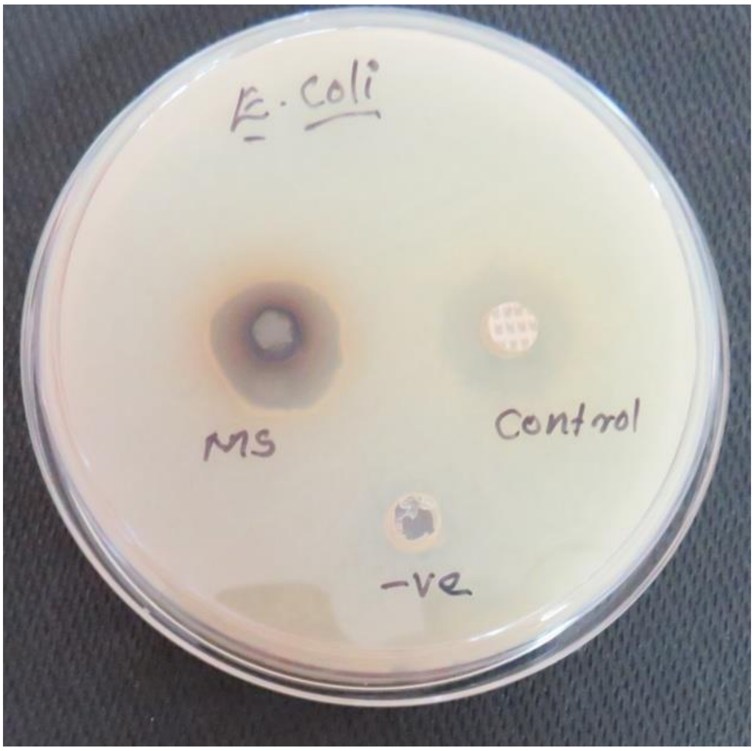


PLATE 13

ANTIBACTERIAL TEST (E – COLI)

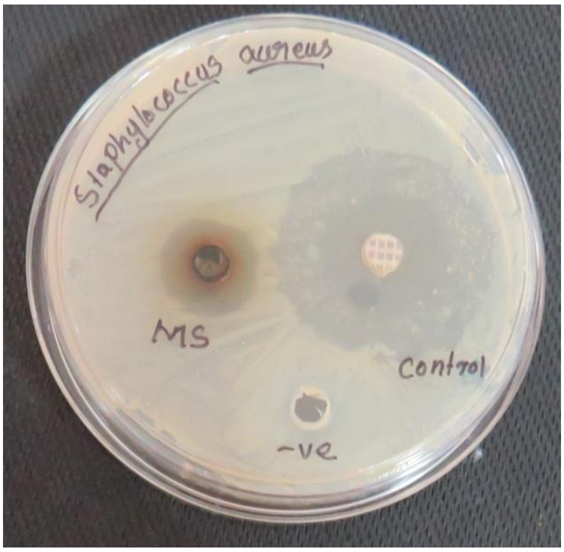


PLATE 14

ANTIBACTERIAL TEST (STAPHYLOCOCCUS)

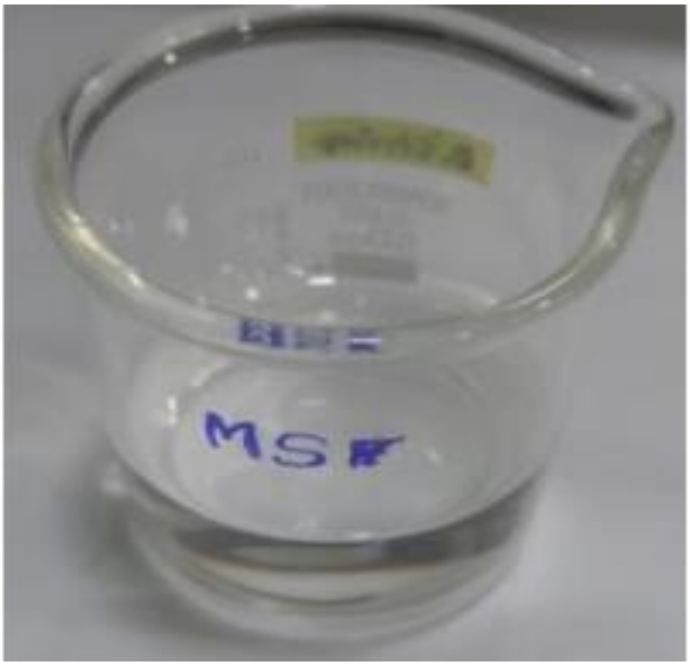


PLATE 15

TOXICITY TEST

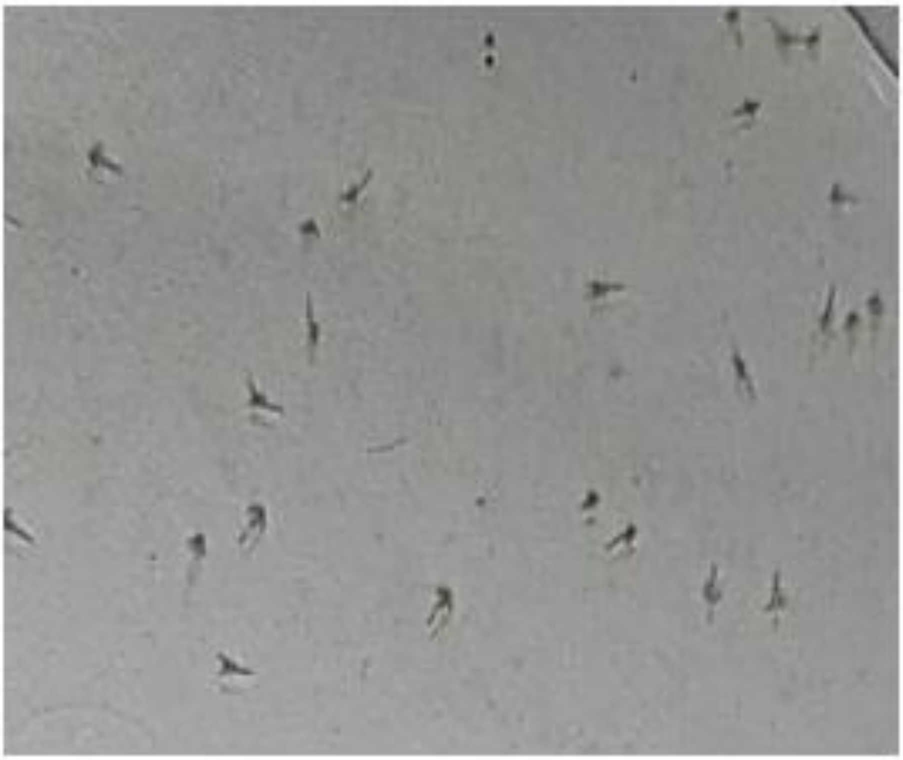


PLATE 15

TOXICITY TEST

PLATE 16

GSM CUTTER

PLATE 17

FABRIC THICKNESS TESTER

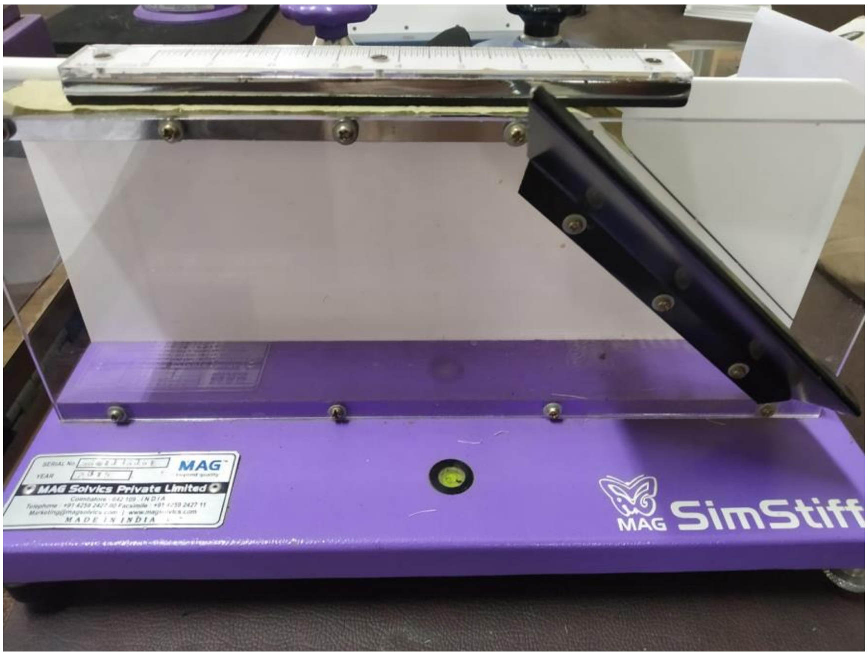


PLATE 18

FABRIC STIFFNESS TESTER

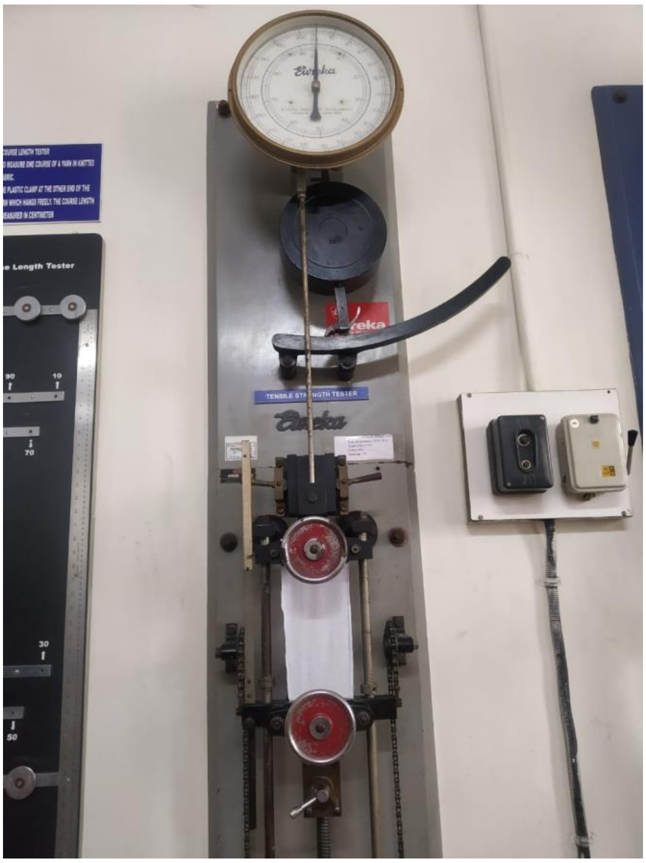


PLATE 19

FABRIC STRENGTH AND ELONGATION TESTER

PLATE 20

FABRIC WICKING TEST

PLATE 21

FABRIC SINKING TEST

PLATE 22

DEAD MOSQUITO DUE TO TREATED FABRIC

5. SUMMARY AND CONCLUSION

The summary and conclusion pertaining to the study entitled "**Anti-bacterial and Mosquito repellent efficiency of Woven and Nonwoven fabric treated with Mexican sunflower**" are summarized here

The world cotton production uses more chemicals per unit area than any other crop and accounts to a total of around 25% of the world's pesticides. Anti-microbial textiles with improved functionality find a variety of applications such as infection control and barrier control (Rajendran et al,2016), health and hygiene commodity. Many opportunities are available to add value and improve products by incorporating novelty finishes to protect the textiles against microbial infestation. Demand for the hygienic clothing is on the rise and the green minded customers are opting for eco-friendly textile materials treated with medicinal herbs. These herbal textiles are not only permanently effective but also eco-friendly (Sathianarayanan et al,2010).

The present study on the mosquito repellent efficiency of the Mexican sunflower leaf extract finished on the cotton woven and non-woven fabrics and the mosquito repellent rate was tested by improved mosquito cage test method. The natural material treated with herbal extract is being capable of repelling mosquito on the fabric to a greater extent. The herbal products are eco-friendly and quite stable for prolonged period, and the above findings would be helpful for the scientific community in finding the right durable and reusable textiles for various medical applications.

In this research, "**Anti-bacterial and Mosquito Repellenct Efficiency of Woven and Nonwoven Fabrics Treated with Mexican Sunflower Leaf Extract"** with the following objectives,

- To optimize the concentration of selected plant extract for finishing woven and non-woven material.

- To analyse the multifunctional efficiency of selected plant extract
- To finish the woven and non-woven fabrics with selected plant extract
- To assess the multifunctional effect of plant extract finished on woven and non-woven fabrics.

EXPERIMENTAL PROCEDURE

Pre-treatment

The cotton woven and nonwoven 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 *tethonia diversifolia* 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 *tethonia diversifolia* 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 woven and nonwoven fabric is finished using two different methods. The de-sized fabrics was heated into the extracted solution for 30mins. The fabric was treated with two different concentration of *tethonia diversifolia* extract liquid.100 % extraction and .50%extraction in boiling method. The material liquor ratio is 6:180. The cotton woven and nonwoven fabric treated with the extract of *tethonia diversifolia* was carried out at optimized concentration with constant temperature for constant time interval. For dip and dry method is 24 hours. In dip and dry method with two different concentration with two different time in room temperature. For boiling method with two different concentration with two different time in 50degree Celsius and 100 degree Celsius.

FINDINGS OF THE STUDY

- The general appearance of the treated fabrics was excellent. The texture of the fabrics treated were rates as soft, in woven fabric. Evenness of the fabric also rated even.
- Extract of leaf is treated with two different bacteria namely ***Staphylococcus aureus*** and ***E.coli.*** From the result it is clear that extract have antibacterial activity.
- The *tethonia diversifolia* extract is comparatively not toxic than $K_2Cr_2O_7$ which shows maximum lethality of shrimps at higher concentration. Hence it is concluded that the extract is not toxic.
- the fabric weight of the treated samples has increased after treatment. The maximum weight was occurred in WCB100 sample.
- The stiffness increased in the fabric after finishing along warp direction and weft direction. the maximum stiffness was occurred in WCB100 sample.
- Fabric thickness was found to be increased. The maximum thickness was occurred in NW50 sample.
- Strength of the woven cotton sample in warp and weft direction increased and also elongation of the fabric increased in both warp and weft direction. The maximum strength and elongation occurred in WCS50 and WCS100.

- The abrasion resistance of the fabric has decreased in the entire treated sample after treatment. But the maximum abration was occurred in WCS100 sample.
- Wicking property has increased. The maximum wickablity was in WCS100 sample.
- The absorbency rate has increased in the treated. The maximum absorbancy was in NW50 sample.
- Mosquito death rate was maximum in NW100 and WCS100. Hence it is concluded that the death count increased after the treatment of dip and dry method by using *tethonia diversifolia* extract. The treated fabric has good result of mosquito repellent compared to original cotton woven and nonwoven fabric

CONCLUSION

Mexican sunflower leaf extract is best suited for treating woven and nonwoven fabrics to add functionality of the fabrics. Treatment with the selected extract has enhanced the properties of woven and nonwoven fabrics except for the stiffness of cotton fabric treated through boiling method. Treated fabrics possessed excellent mosquito repellent and antibacterial properties. Woven treated fabrics could be made into insect repellent patches and medical textile products. Treated nonwoven fabric would be suited for preparing single use mosquito repellent patches. Selected disposable medical textile product could also be tried with treated nonwoven fabric.

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APPENDIX – i

Woven cotton original

Woven soaking method

Concentration 50

Woven soaking method

Concentration 100

Woven boiling method

Concentration 50

Woven boiling method

Concentration 100

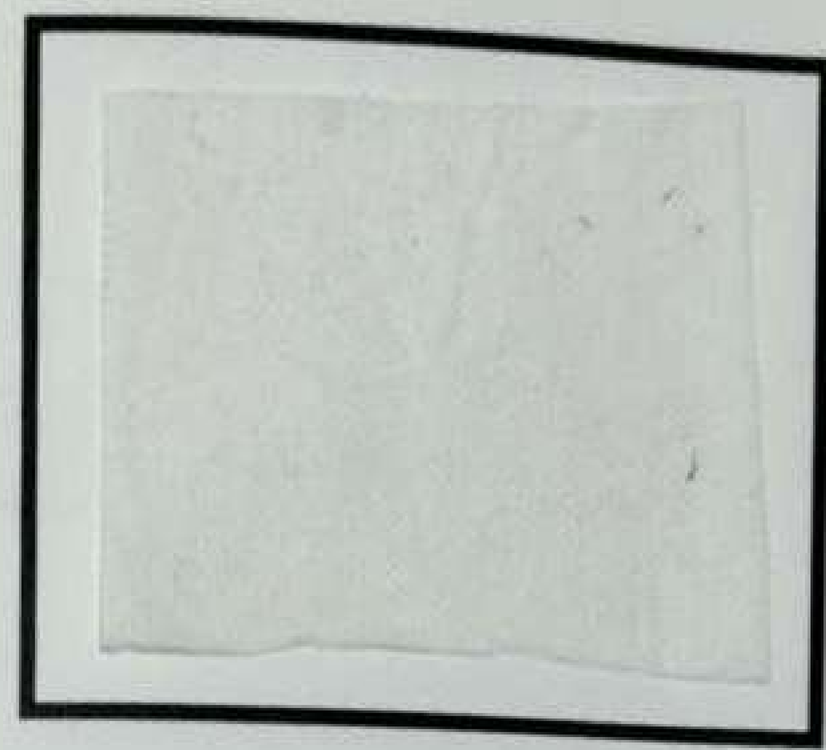
APPENDIX – ii

Non-woven cotton original

Non-woven concentration 50

Non-woven concentration 100

APPENDIX – i



Woven cotton original

Woven soaking method

Concentration 50

Woven soaking method

Concentration 100

Woven boiling method

Concentration 50

Woven boiling method

Concentration 100

APPENDIX – ii

Non-woven cotton original

Non-woven concentration 50

Non-woven concentration 100