A Comparative study on Antimicrobial activity of *Ocimum tenuiflorum. Linn* leaves and stem extract on Organic cotton

By

S. Sovya

(*21PBX009*)

A Thesis Submitted to the
Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore-641 043

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

In

Bio Textiles

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Certified as Bonafide Research Work

15/5/23

Signature of the Head of the Department

Signature of the Guide

DECLARATION

I declare that the dissertation entitled "**A Comparative study on Antimicrobial activity of *Ocimum tenuiflorum. Linn* leaves and stem extract on Organic cotton** " 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. R. PRABHA, M.Sc., Ph.D., Assistant 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.

15/5/23.

Signature of the Candidate

CERTIFICATE FROM THE SUPERVISOR

I certify that dissertation entitled **"A Comparative study on Antimicrobial activity of *Ocimum tenuiflorum. Linn* leaves and stem extract on Organic cotton"** submitted for the degree of Master of Science (M.Sc.,) Bio Textiles by SOVYA S (21PBX009) 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

Asst. Prof (SG)

Signature of the Supervisor with Designation

15/5/23

Signature of the HOD

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PREFACE

PREFACE

The Vaishnava traditions across the Indian subcontinent, including among the Hindu diaspo- ra overseas, hold the Indian tulsi (*Ocimum tenuiflorum*) to be sacred. It is the most cherished plant in current Hinduism. Generally speaking, the plant is personified as a lady who was a great devotee of God Vishnu before becoming a plant (called Vrinda or Madhavi). Examining both the traditional and scientific points of view is crucial. According to ancient writings, Oci- mum was originally a single plant. Still, more recent research from the University of Punjab has illuminated the evolutionary history of *Ocimum tenuiflorum* and offers intriguing hints as to the origin of this sacred plant as well as its distinction from other basil varieties outside of India. The Haplogroups assert that the species is a monophyletic clade that has evolved at a relatively slow rate. For the subsequent experiment (process) in upcoming projects, the plant's qualities are researched and its properties are assessed. One of the valuable plant sources for medicine is Ocimum. It is among the plants that are most frequently ingested. It belongs to the Lamiaceae plant family's Ocimum genus and is a perennial herbaceous bush with culinary and fragrant uses. It contains vitamins (A and C), calcium, iron, and zinc. Its chlorophyll pigment has antibacterial and insecticidal effects. Ocimum leaves have the power to clean up tainted water. There is some scientific support for its anti-inflammatory, antioxi- dant, analgesic (pain reliever), antipyretic (fever reducer), hepatoprotective (liver protector), cancer fighter, diabetes preventer, blood vessel protector, destresser, immunological booster, and many other health benefits. The project concentrates on the Krishna Tulsi (Ocimum te- nuiflorum) extraction, evaluation of components, and the antimicrobial activity of the same. This analysis and evaluation are all about both the stem and leaf of the plant species called Lamiaceae. By the previous studies of this tulsi species, there is significant evidence of the phenolic, and flavinoid contents in it, also the plant is on its own an excellent antimicrobial agent, its roots or its stem, its leaves.

Keywords

Ocimum tenuilflorum; GCMS; Methanol extraction; water extraction; antibacterial; antifungal;

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INTRODUCTION

1 Introduction

In India, the textile industry ranks second only to agriculture. Textile is one of India's oldest businesses, contributing over 14% of manufacturing value addition, accounting for almost one-third of our gross export revenues, and employing millions of people. The textile sector holds a particular significance in our country. One of the first to emerge in India, it accounts for 14% of overall industrial production, approximately 30% of total exports, and is the second largest employer after agriculture. Nobody knows where the first cotton fabric was made. However, archaeologists have discovered evidence that humans in India, Central and South America were weaving cotton as far back as 4,000 years ago. And we know that by 1500 A.D., Cotton was being grown throughout the Americas, Eurasia, and Africa.

Basically, Organic cotton is grown with environmentally friendly processes and resources. Organic farming practices replenish and preserve soil fertility, limit the use of hazardous and persistent herbicides and fertilizers, and promote biological diversity. Third-party certification organizations ensure that organic producers utilize only methods and materials approved for organic production. Organic cotton is farmed without the use of hazardous and persistent pesticides or synthetic fertilizers (Baran, 2018).

Earlier, Cotton was produced, harvested, ginned, spun, and woven completely by hand until the late 18th century. Cotton fabric was only available to the rich. Sir Richard Arkwright's water-powered spinning machine, and Eli Whitney's cotton gin, barely twenty years later, revolutionized everything. The cotton gin, a hand-cranked apparatus that separated the plant's fibers from its seeds, enabled a worker to clean fifty pounds of cotton each day rather than one. Following the advent of the cotton gin, the United States rose to become the world's leading provider of cotton fiber.

Unfortunately, slavery thrived with the cotton business. Though India was historically the leader in cotton fabric production, with the onset of the industrial revolution, England quickly dominated the market. The affluence brought forth by large-scale cotton fabric manufacturing benefited neither textile workers in England nor slaves in the United States. Indian mills were eventually able to acquire the new machinery and retake control of the market.

Organic cotton is, without a doubt, the most skin-friendly, calming, and safe natural fiber. While conventional cotton might occasionally be sensitive to infant skin, Organic Cotton never is. It is the excellent material for protecting and cleaning newborn infants, especially for manufacturing garments, bandages, covering and cleaning wounds, baby crib beddings, baby outfits, towels, and

hundreds of other items. It may also be used safely in surgical procedures when contamination from any source can be lethal. Organic Cotton SeedOil, a by-product of organic cotton, has several use in snacks and livestock feed.

The organiccotton fiber as textile is a great advantage for the less pollution of the environment as 50% ofthe waste is of textile in the environment. So my utilization of organic cotton either as yarn orfabric is on the thought of sustainable textile part. As it is a cellulosic fiber, the part of dyeingis easier also cotton has a good absorbency than any other fibers so working with this on my project will give great output.

Long before the prehistoric period, plants were employed for medical purposes. Herbal usage was documented in ancient Unani texts, Egyptian papyrus, and Chinese literature. For almost 4000 years, Unani Hakims, Indian Vaids, and European and Mediterranean cultures have used plants as medicine. Indigenous societies such as Rome, Egypt, Iran, Africa, and America employed herbs in their healing rituals, while others created traditional medical systems such as Unani, Ayurveda, and Chinese Medicine in which herbal remedies were used systematically.

Traditional medical systems are still widely practiced on a variety of fronts. Population growth, insufficient drug supply, prohibitive treatment costs, side effects of several synthetic drugs, and the development of resistance to currently used drugs for infectious diseases have increased emphasis on the use of plant materials as a source of medicines for a wide range of human ailments. India was renowned as a rich storehouse of medicinal herbs among ancient civilizations. In India, the forest is the primary reservoir for a huge numberof medicinal and aromatic plants, which are mostly harvested as raw materials for the manufacturing of pharmaceuticals and perfumery goods. IN INDIA, over 8,000 herbal medicines have been codified in AYUSH systems (Baran, 2018).

Aloe vera, Tulsi, Neem, Turmeric, and Ginger are medicinal plants that treat a variety of illnesses. In many regions of the country, they are regarded as home cures. It is common knowledge that many people use Basil (Tulsi) to make medications, black tea, for pooja, and for various purposes in their daily lives. The Vaishnava traditions across the Indian subcontinent, including among the Hindu diasporas overseas, hold the Indian tulsi (*Ocimum tenuiflorum*) to be sacred. It is the most cherished plant in current Hinduism. Generally speaking, the plant is personified as a lady who was a great devotee of God Vishnu before becoming a plant (called Vrinda or Madhavi). Examining both the traditional and scientific points of viewis crucial.

According to ancient writings, Ocimum was originally a single plant. Still, more recent

research from the University of Punjab has illuminated the evolutionary history of *Ocimum tenuiflorum* and offers intriguing hints as to the origin of this sacred plant as well asits distinction from other basil varieties outside of India. The Haplogroups assert that the species is a monophyletic clade that has evolved at a relatively slow rate. Krishna tulsi (*Ocimum tenuiflorum*) is a member of the Lamiaceae family. Krishna Tulsi (*Ocimum tenuiflorum*) hasboth traditional and medical uses. Krishna tulsi has a pleasant flavor and gives moderate stimulation to the body, mind, and soul (A. M et al. 104-110).

Krishna tulsi (*Ocimum tenuiflorum*), also known as Purple leaf tulsi, is well-known for its peppery, sharp, and crisp flavor. Its leaves and dark stalks are purple in color. Tulsi blossoms are tiny, purple to reddish in hue, and grow in small, compact clusters on cylindrical spikes. Essential oils, carbohydrates, flavonoids, and proline are the primary chemical components of *O.tenuiflorum*. It also has more linalool and less methyl chavicol, nerol, gera-niol, citral, and Ursolic acid. *O.tenuiflorum* has anti-inflammatory, antioxidant, anti-tumoral,anti-fertility, anti-diabetic, antifungal, and antimicrobial, cardio-protective, analgesic, anti- spasmodic, and adaptogenic qualities, as well as the ability to reduce the development of a range of cancer cell lines in vitro. *O.tenuiflorum*'s therapeutic virtues have been recorded in Ayurveda for thousands of years (Pattanayak et al., 2010).

In fact, Ayurvedic medicine considers this plant to be a "elixir of life," and it is used to treata variety of ailments, including common colds, headaches, stomach disorders, inflammation, heart disease, poisoning, and malaria, as well as psycho-physical discomfort, asthma, and conjunctivitis (Piras et al.).

The plant is planted in many Hindu houses, generally in the courtyard in a special four-sided structure, and the presence of a holy basil plant is thought to increase devotion, induce meditation, purify, and protect. Devotees usually pray in the morning and evening with mantras and offerings of flowers, incense, or Ganges water, and Tuesdays and Fridays are regarded most sacred. Even the ceremonial act of watering and caring for the plant whichis often performed by the women of the family is considered worshipful and virtuous. Many temples grow holy basil, and the woody stems of dead plants are used to manufacture sacred japamala beads (Rosaries).

Tulsi Vivah, a celebration in which families and temples ceremonially wed holy basil to Vishnu, marks the start of the Hindu wedding season. Water steeped with the leaves is frequently offered to the dying to assist elevate their souls, and funeral pyres are typically adorned with holy basil branches in the hopes that the departed may achieve moksha and be freed from the cycle of

rebirth. When the Victoria Gardens in Bombay, India, were being built, the men who worked there were plagued with mosquitoes. Tulsiplants were planted throughout the whole perimeter of Victoria Gardens to repel mosquitoes.

The leaves, stem, flower, root, and seeds are used to cure flu, bronchial asthma, malaria, diarrhea, skin ailments, arthritis, persistent fever, and bug bites. Tulsi stimulates the body's basic metabolism and aids in weight loss. Tulsi helps to eliminate pimples and acne from the skin. It is high in antioxidants, which assist it to fight premature ageing. Tulsi also strengthens our hair roots, hence avoiding hair loss. Tulsi's antifungal characteristics helpto prevent the growth of fungus and dandruff. To repel insects, dried Tulsi leaves have been sprinkled with stored grains for ages (Venkat, 2019).

The main source for this project is *O.tenuiflorum* (Krishna Tulsi). It is chosen becauseof various reasons like its properties, components, importance in Ayurveda and its advantages of curing diseases. And as per the previous paper study this source has been used in a few articles and mostly to either validate its components or compare the antimicrobial properties with some other Ocimum, but this study is something more related to textile clothing. Tulsi aids in the removal of pimples and acne from the skin. It is high in antioxidants, which aids inthe prevention of premature ageing. Tulsi also fortifies our hair roots, which helps to prevent hair loss. Tulsi's antifungal qualities help to keep fungus and dandruff at bay.

Dehydrated Tulsi leaves were commonly put with stored grains for millennia to repel insects. In addition to repelling insects, Tulsi leaf extracts may be used to bug bites and stingsto relieve discomfort. They also significantly minimize edoema and resulting discomfort. Furthermore, Tulsi helps to detoxify the blood on a regular basis. Tulsi, which is high in vitamin K and antioxidants, improves hair by boosting blood circulation and encouraging hair growth, among other things. Tulsi is the star ingredient for good hair and skin since it is highin vitamins, minerals, electrolytes, and phyto-nutrients (Garg, 2022).

Camphor, eucalyptol, and eugenol are three of the 54 chemicals found in Tulsi leaves,flower spikes, or essential oil that are thought to be responsible for this function. Because S. aureus (including MRSA), P. aeruginosa, and E. coli are significant pathogens leading infections of the soft tissue and skin (Yamani et al., 2016). Tulsi essential oil might be a beneficialtopical antimicrobial agent for the treatment of these species' skin infections. Other certain benefits include their safety in comparison to other pharmaceuticals and the absence of significant adverse effects. This is considered one of the most cherished and holistic plants usedin traditional therapies in India for

many years, and practically every component of this planthas been discovered to have medicinal effects (Niu et al., 2011).

Skin and soft tissue infections (SSTIs) pose significant morbidity and economic cost to the population. Staphylococcus aureus, Pseudomonas aeruginosa, and Escherichia coli are the most common causes of these infections, according to the SENTRY Antimicrobial Surveillance Program (Dryden, 2010). The extracts' cyto-toxicity reduced in direct proportionto their concentration. When cells were exposed to a concentration of 20 mg/ml, there wasa less than 20% reduction in cell viability. Concentrations of 20 mg/ml in concentrated leaf extract and essential oils were both within the predicted range since they did not cause a 20% or greater reduction in cell viability and were thus not cyto-toxic. Results for the cell viability showed no influence at concentrations below 20 mg/ml (Yamani et al., 2016).

Zones of inhibition were discovered using a disc diffusion experiment across both Gram-positive and Gram-negative organisms; however effect against S. aureus was stronger than against Gram-negative species (Mahmood et al., 2008). Both Gram-positive and Gram-negative species were effectively suppressed, as demonstrated by a drop in optical density, while P. aeruginosa slightly outperformed S. aureus in these test conditions (Mishra and Mishra, 2011). In tests against P. vulgaris, S. aureus, P. aeruginosa, and E. coli, Tulsi essential oil from one subspecies of *O.tenuiflorum* performed better than extracts from two other subspecies of Tulsi (Helen et al., 2011).

Gastritis and liver issues are treated with a decoction of the leaves. To treat dysentery, patients are often given the juice of fresh leaves. An Ocimum suave methanolic extract was shown to treat chronic stomach ulcers in experimental mice, according to a research. Ocimum sp. is antimalarial, and so are pepper, turmeric, and onion. Larvicidal, and insecticidal effects of oil. -bisabolene (13-20%), methyl chavicol (3-19%), 1,8-cineole (9-33%), eugenol (4-9%), (E)--bisabolene (4-7%), and -terpineol (1.7-7%) are the main components of tulsi oil.In Indian gardens, tulsi is frequently used as a mosquito deterrent. The essential oils from tulsi are totally larvicidal. Additionally, it has been shown that tulsi has amazing anti-malarial properties. The primary component, eugenol, is what gives the product its repelling properties. A paste produced from Tulsi leaves is used to cure ringworm infection (Singh et al., 2010). Tulsi is effective against parasites and worms. It has been demonstrated that Tulsi leaves possess strong antifungal activities against Aspergillus species. Ocimum has strong antibacterial activity against Vibrio cholerae, E. coli, Proteus and Staphylococcus aureus, Klebisella (a bacterium that causes pneumonia and urinary tract

infections), and E. coli. Additionally, it has been demonstrated that O.tenuiflorum possesses antiviral properties againstBovine Herpes Virus 1 (Chiang LC, 2005).

It is believed that Ocimum sp. essential oils, which contain eugenol, carvacrol, methyl eugenol, and caryophyllene, are principally to blame for the variety of antibacterial activities. Oneof the main components of tulsi leaves is ursolic acid, which has been said to have anti-fertility effects. Its anti-estrogenic activity, which may be to blame for male spermatogenesis arrestand female ovum implantation suppression, has been related to this effect (Prakash P, 2005). This ingredient might work as a safe anti-fertility medication. Tulsi leaves reduce the activityof sertoli cells, which prevents male spermatogenesis. Tulsi extends life span amid anoxic stress and has an antihypoxic effect. In experiments on rabbits, tulsi has been found to lessenoxidative stress (Raj V, 2009).

Extraction process is all about filtering the components that are required for the task. For a long time, maceration was a common and economical DIY approach for preparing tonic. Furthermore, this approach was employed to extract essential oils and active chemicals from plant sources. In general, the maceration technique includes multiple extraction phases (zeghina, 2019). Pharmaceutical extraction is the separation of medicinally active sections of plant or animal tissues from inactive or inert components using selected solvents in typical extraction processes.

The products derived from plants are relatively impure liquids, semisolids, or powders designed solely for oral or exterior consumption. Decoctions, infusions, fluid extracts, tinctures, pilular (semisolid) extracts, and powdered extracts are examples of such preparations. Galenicals are popular names for such concoctions, after Galen, a second-century Greek physician. The goals of standardized crude drug extraction processes are to get the therapeutically required part while removing inert material by treatment with a selective solvent knownas menstruum. The resulting extract may be set for use as a medicinal product as a form of tinctures and fluid extracts, or it may be broken down to separate out individual entities of chemicals such as ajmalicine, hyoscine, and vincristine, which are modern drugs.

As a result,standardization of extraction techniques has a substantial impact on the ultimate potency of the herbal medication. The initial stage in separating selected products of nature from basic materials is extraction. According to the extraction principle, extraction processes include solvent extraction, distillation, pressing, and sublimation.

The most common approach is solvent extraction. Natural product extraction proceeds as follows:

(1) The solvent penetrates the solid matrix;

(2) The substance being extracted dissolves into the solvents;

(3) The solute diffuses out of the solid matrix;

(4) The extracted solutes are collected.

Any component that increases the diffusivity and solubility in the preceding phases will make the extraction easier. The extraction efficiency is affected by the extraction solvent's characteristics, the size of the particle of the material being extracted, the solvent-to-solid ration, the temperature of the extraction, and the extraction period.

The primary distinction is that the Soxhlet extraction procedure uses less solvent than maceration. Other parameters, such as temperature and solvent-sample ratio, must be carefully specified during Soxhlet extraction. Extraction technique selection is frequently influenced by the phyto-constituents to be extracted as well as the kind of bio-actives containedin the substrate being extracted.

Weaving in particular and the creation of fabrics in general are perhaps as old as recorded human history. A piece of fabric to cover their body for modesty and to shield themselves from the harmful effects of the environment was one of the first things that early humans needed. Science and art combine to create weaving. Even with all the technological advancements, weaving is still not a process that can be tightly controlled. That is, the individual fiber, which is the smallest significant building unit in a woven structure, is difficult toregulate. Weaving is a fascinating technology because of this aspect. Fibers are mostly used in the production of fabric. The natural fibers are made up of both plant and animal fibers.

Following the formation of the fabric, it is often finished and/or dyed, modifying the qualities of the raw fabric for the intended application. The most popular techniques for making fabric include weaving, braiding, knitting, tufting, and the production of non-woven materials. Warp and filler threads are interlaced perpendicular to one another during weaving. Warp and filler yarns can be interlaced in an almost infinite number of ways. Every method results in a unique fabric structure.

These key methods for producing fabrics each result in distinctive architectures. Every technology of producing fabrics has given rise to large enterprises in practically every nation on earth. Another 50 nations make woven textiles in varying quantities, and about 40 countries have significant textile industry. Woven textiles make up over 70% of all fabrics manufactured worldwide.

There are several methods to categorize woven fabrics:

(i) Grouping based on weave type, including plain, twill, satin, leno, etc.

(ii) Grouping by commonly used terms, such as denim, cheesecloth, percale, etc.

(iii) The division of textiles into heavy and light categories based on weight.

(iv) Grouping based on coloring technique, such as yarn or piece colored, stock dyed, or solution dyed.

End-use classification: textiles for industrial, residential, and apparel application.

The simplest type of weaving is called plain weave. Both the warp and the filler threads are interlaced one-over-one below. The fabric has the same texture on the top and bottom sides because the simple weave formula repeats on two warp and two filler yarns. Only two harnesses are needed for plain weave. However, if the warp density is greater than 50 ends per inch (EPI), it can be woven on more than two harnesses. It is frequently weaved on four harnesses. The simple weave has the most yarn crimp in its structure because of 1/1 interlacing.

As a result, compared to other patterns with less crimp in their structure, the plain weave has a low modulus. In the warp direction, the warp rib formula features an alternate interlacing pattern from the 1/1 interlacing in the filling direction.

By clustering the filler yarns together, this produces a pattern that features ribs or texture ridges throughout the cloth in the warp direction. All warp rib repeat units feature two warp yarns. The second warp deviates from the formula whereas the first warp adheres to it.

Consequently, any warp rib design needs at least two harnesses. The sum of the digits in the warp rib formula represents the number of filler yarns in the repetition unit. There are two types of warp rib formulae: regular and irregular. A regular or balanced warp rib formula has the same number as the numerator and denominator, for example, 2/2, 3/3, etc. The digits in an irregular or unbalanced formula are various numbers, for example, 2/3, 4/2, 2/3-3/3, etc. Even though just a portion of the equation's numerator and denominator have the same value, the design is still seen as having uneven ribs.

In the filling direction, the filling rib formula has a distinct interlacing pattern from the warp direction's 1/1 interlacing. As a result, the pattern includes ridges or ribs that run across the cloth in the direction of the filling. The clustering of warp yarns is what results in these ribs. All filling ribs feature two filler yarns in the repetition units, just like the warp ribs do. While the second filling deviates from the formula, the first filling adheres to it. Consequently, any filling rib design needs at least two harnesses. The sum of the digits in the filling rib formula represents the number of warp yarns in the repetition unit. The formulas for filling the

ribs, whether regular or irregular, also apply. The interlacing pattern of the warpyarns results in the twill weave in a stepwise succession. Each warp yarn begins its interlacing pattern on a separate filler yarn and follows the same rules. As a result, the cloth develops a diagonal line known as the Twill line, which is unique to this pattern.

The twill line is an impression created by the design's interlacing that takes place in steps rather than a literal line. The twill weaves are referred either as right-hand or left-hand twills depending on the orientation of the twill line. The twill line in right-hand twill extends from bottom left to higher right. The twill line in left-hand twill extends from lower right to higher left. The reverse of a cloth having right-hand surface twill is left-hand twill. There are two types of twill weave formulas: regular and irregular. A regular or balanced twill formula has the same amount of numbers, for example, 2/2, 3/3, 4/4, etc. The digits in an erratic or imbalanced formula are distinct numbers, such as 1/3, 4/2, 2/3-3/2-1/1, etc. The unit cell of the pattern is determined by the sum of the digits in the formula, which also provides the bare minimum of harnesses needed to weave the design (at least three harnesses are needed for a twill weave).

By considering the above statements and facts the research work is on the topic "A comparative study on Antimicrobial activity *of Ocimum tenuiflorum. Linn* leaves and stems over organic cotton with the following objective:

1. To know the property of *O.tenuiflorum* fiber
2. To understand the extraction method of leaves and stems of *O. tenuiflorum*
3. To execute a pilot study on extraction process
4. To select a suitable method of fabrication and prepare samples
5. To finish the fabric with extract and test its antimicrobial activity

REVIEW OF LITERATURE

2 Review of Literature

The review of literature pertaining to the study entitled "**A Comparitive study on Antimicrobial activity of *Ocimum tenuiflorum. Linn* leaves and stems over Organic cotton**" is discussed under the following aspects:

2.1 Natural fiber

2.1.1 About Natural fibers

2.1.2 About Cellulosic fibers

2.1.3 History of cellulosic fibers

2.1.4 Application of cellulosic fibers

2.2 Ocimum tenuiflorum

2.2.1 About *O.tenuiflorum*

2.2.2 History and Genesis of *O.tenuiflorum*

2.2.3 Properties and Characteristics of *O.tenuiflorum*

2.2.4 Components of *O.tenuiflorum*

2.3 Organic Cotton

2.3.1 About Organic cotton

2.3.2 History of Organic cotton

2.3.3 Importance of Organic cotton

2.3.4 Properties and characteristics of Organic cotton

2.3.5 Use and applications of Organic cotton

2.4 Fabric production

2.4.1 Plain weave

2.4.2 Twill weave

2.5 Pre-treatment of fabric

2.5.1 Desizing

2.5.2 Scouring

2.6 Finishing

2.6.1 Kinds of finishing

2.6.2 Functional finishing

2.7 Antimicrobial finish

2.7.1 Fungal development

2.7.2 Bacterial development

2.7.3 Exhaust dyeing method

2.1 Natural fibres

2.1.1 About Natural Fibres

Due to the fastest growth of cotton, which climbed by 26 million tons in 2018, the production of textile fibers increased by 5% to 103 million tons on a worldwide scale, while the production of synthetic fibers increased to over 72 million tons and the production of other natural fibers barely reached 6 million tons.

Between 1960 and 2017, the average global consumption of textile fiber per person more than quadrupled, from 5 to 12.6 kg. While textile fiber consumption per capita climbed fourfold in developing nations during that time, it increased by 156% in industrialized nations and declined by 3% in countries in Central and Eastern Europe and the former Soviet Union. The population of developing nations was 3.3 times larger in 1960 than that of industrial countries, and it was 6.6 times larger in 2017. This population rise has increased the importance ofemerging countries in the global consumption of textile fibers (Kozlowski, 2012).

2.1.2. About Cellulosic fibers

The ethers or esters of cellulose, which can be found in the bark, wood, or leaves of plants or in other plant-based materials, are used to make cellulose fibers. In addition to cellulose, the fibers may also contain hemi-cellulose and lignin; the proportions of these substances in the fibers affect their mechanical characteristics. Due to their comparable characteristics to designed fibers, cellulose fibers are mostly used in the textile industry as chemical filters, fiber-reinforcement composites, and as alternative option for bio-composites and polymer composites.

Because natural cellulose fibers are only treated to the extent necessary to prepare them for use, they may still be identified as coming from the original plant. For instance, cotton fibers resemble the soft, fluffy cotton balls from which they are derived. The strong fibrous strands of the flax plant resemble linen fibers in appearance. All “natural” fibers undergo a separation process from plant components that aren’t utilized in the finished product, which often involves harvesting, separating from chaff, scouring, etc. A large amount of hydrogen bonding between OH groups on neighboring chains is made possible by the existence of linear chains made up of thousands of connected glucose units, which causes them topack tightly into cellulose fibers. Because of this, cellulose doesn’t interact much with water or other solvents.

For instance, cotton and wood both have high mechanical strength and are fully insoluble in water. Like amylose, cellulose does not have a helical shape that allows it to bind to iodine and produce a colorful substance.

Similar to how synthetic fibers like polyester or nylon are produced, manufactured cellulose fibers are formed from plants that are processed into a pulp and then extruded. One of the most popular "manufactured" cellulose fibers is rayon or viscose, which may be produced from wood pulp ("Cellulose Fiber - Wikipedia").

2.1.3 History of cellulosic fibers

Anselme Payen, a French scientist, extracted cellulose from plant materials in 1838 and characterized its chemical composition. Hyatt Manufacturing Company created celluloid, the first effective thermoplastic polymer, in 1870 from cellulose. In the 1890s, cellulose was used to produce rayon (sometimes known as "artificial silk"), and cellophane was created in 1912. Another cellulosic substance, acetate, was created in 1893 by Boston resident Arthur D. Little and turned into a film. The Celanese Company created the first acetate fiber-based commercial textile applications in 1924. In 1920, Hermann Staudinger identified the cellulose polymer structure. In 1992, Kobayashi and Shoda successfully, chemically produced the molecule for the first time (without the use of any enzymes obtained from living organisms) ("Cellulose Fiber - Wikipedia").

The world's nations' economies depend heavily on the cotton and cotton textile sectors. Since it was a significant source of income during the world's industrial revolution, cot- ton played a significant role. With an average global price of around US $ 1.75 per kilogram of lint cotton in 2018–2019, the globe produced 26.26 million tons of cotton.

Throughout the 1960s, cotton output grew steadily. Commercial biotech cotton types grown in the world's major cotton-producing nations—the United States, India, China, Brazil, and Pakistan—helped drive the explosive growth of cotton output, which increased from 13.8 million tons in the 1980s to 19.5 million tons in the 2000s. In 2011, the world's cotton production surpassed 27 million tons, and it stayed there until 2018 (Kozlowski, 2012).

2.1.4 Application of cellulosic fibers

Composites

A composite material is a type of material that is often created by mixing a fiber with a binder(matrix). This mixture combines the fiber's characteristics with the matrix's features to pro- duce a new material that might be more durable than the fiber by itself. Cellulose fibers are used to make some fiber-reinforced materials, including bio-composites and fiber-reinforced plastics, when coupled with polymers. The table lists several polymer matrices as well as the cellulose fibers that are frequently combined with them. The following physical and mechanical attributes are of special relevance because they can affect the behavior of the composite since they are macroscopic features of the fibers:

- Dimensions: The transmission of efforts to the matrix is influenced by the connection between the length and diameter of the fibers. Plant fibers' uneven cross-section and fibrillated appearance also aid in holding them in place inside a weak matrix.
- Internal void volume and water absorption: Fibers have a lot of huge internal spaces and are rather permeable. As a result, the fibers soak up a lot of matrix when submerged in the binding substance. High absorption may result in matrix swelling and fiber shrinking. However, ahigh void volume makes the finished composite material lighter, more acoustically absorbent,and with lower thermal conductivity.
- Tensile strength: On the whole, comparable to the fibers of polypropylene.
- Elasticity: Cellulosic fibers have a low elasticity modulus. Its application in creating components that operate in the post-cracked stage and have high energy absorption and resistanceto dynamic forces is determined by this.

Textiles

Regenerated cellulose is used to make fibers like rayon (including modal and the more recently created Lyocell) for the textile industry. The pulp used to make cellulose fibers dissolves during production. There are two forms of cellulose-based fibers: modified cellulose, such as cellulose acetates, and regenerated or pure cellulose, such as from the cupro-ammonium process. Around 1894, the first synthetic fiber, which was first marketed as artificial silk, changed its name to viscose before becoming known as rayon in 1924. In 1865, cellulose acetate, a substance that is comparable, was found. Both rayon and acetate are artificial fibers, but they are not entirely synthetic because they are made from chemically digested feedstock that includes real wood. Additionally, they are not made of silk, a synthetic fiber made of animal proteins. Despite the fact that these synthetic fibers were first found in the middle of the nineteenth century, successful contemporary manufacturing only started considerably later.

Filtration

In addition to enhancing throughput and clarity, the cellulose fibers infiltration/filter aid applications can offer a protective covering to filter components such as powdered cellulose. Make cleanup after filtering simple with ash less, non-abrasive filtration that won't harm pumps or valves. They completely absorb emulsified oil and boiler condensates while efficiently filtering out metallic contaminants. In general, using cellulose fibers as a primary or corrective pre-coat can significantly boost filtering performance in filtration applications.

- Repairing tiny mechanical breaches in the gaskets and leaf seats as well as holes in the filter septum
- Enhancing the filter-aid cake's stability to make it more resilient to pressure fluctuations and interruptions
- Making a pre-coat that is more homogeneous and has no fractures to increase the filtering surface area
- Enhancing cake release and minimizing cleaning needs
- Decreasing soluble contaminants and preventing tiny particle bleed-through during pre-coating ("Cellulose Fiber - Wikipedia").

2.2 Ocimum tenuiflorum

2.2.1 About Ocimum tenuiflorum

Holy basil is a plant that is grown in many Hindu homes, usually in the courtyard in a unique four-sided structure, and its presence is said to enhance devotion, promote meditation, purify, and protect. The most important days are Tuesdays and Fridays. Devotees typically pray in the morning and evening using mantras and gifts of flowers, incense, or Ganges water. The customary act of watering and caring to the plant, that is frequently carried out by the women of the household; is regarded as worshipful and virtue.

Holy basil is grown in many temples, and sacred japamala beads (Rosaries) are made from the woody stems of the deceased plants. The Hindu wedding season begins with Tulsi Vivah, a festival in which families and temples formally wed holy basil to Vishnu. Holy basil branches are commonly used to adorn funeral pyres in the belief that the deceased may reach moksha and be freed from the cycle of reincarnation. Water steeped with the leaves is routinely given to the dying to help raise their souls. The workers who worked there were swarmed by mosquitoes when the Victoria Gardens were being constructed in Bombay, India. To ward

against mosquitoes, tulsi plants were planted all around Victoria Gardens' border (VENKAT, 2019).

2.2.2 History and Genesis of O.tenuiflorum

Flu, bronchial asthma, malaria, diarrhea, skin disorders, arthritis, persistent fever, and bug bites are all treated with the leaves, stem, flower, root, and seeds. Tulsi promotes weight reduction by stimulating the body's basic metabolism. Tulsi aids in the removal of pimples and acne from the skin. It has a lot of antioxidants, which help it fight off premature aging. Tulsi also strengthens our hair roots, which helps to prevent hair loss. Tulsi's antifungal properties aid in the prevention of fungus and dandruff development (VENKAT, 2019).

For centuries, dried Tulsi leaves have been dusted with stored grains to repel insects. *O.tenuiflorum* (Krishna Tulsi) is the primary source for this project. It was chosen for a variety of reasons, including its qualities, components, relevance in Ayurveda, and potential for illness cure. And, according to the previous paper research, this source has been employed in a few papers, usually to confirm its components or compare the antimicrobial characteristics with other Ocimum, but this study is more focused on textile apparel. Tulsi helps to remove pimples and acne from the skin. It is abundant in antioxidants, which help to prevent premature aging. Tulsi also strengthens our hair roots, which aids in the prevention of hair loss. Tulsi's antifungal properties aid in the prevention of fungus and dandruff (Garg, 2022).

Camphor, eucalyptol, and eugenol are three of the 54 chemicals found in Tulsi leaves, flower spikes, or essential oil that are thought to be responsible for this function. Because S. aureus (including MRSA), P. aeruginosa, and E. coli are significant pathogens leading infections of the soft tissue and skin, Tulsi essential oil might be a beneficial topical antimicrobial agent for the treatment of these species' skin infections. Other certain benefits include their safety in comparison to other pharmaceuticals and the absence of significant adverse effects (Yamani et al., 2016).

2.2.3 Properties and Characteristics of O.tenuiflorum

This is considered one of the most cherished and holistic plants used in traditional therapies in India for many years, and practically every component of this plant has been discovered to have medicinal effects. Skin and soft tissue infections (SSTIs) pose significant morbidity and economic cost to the population. Staphylococcus aureus, Pseudomonas

aeruginosa, and Escherichia coli are the most common causes of these infections, according to the SENTRY Antimicrobial Surveillance Program. The extracts' cyto-toxicity reduced in direct proportion to their concentration. When cells were exposed to a concentration of 20 mg/ml, there was a less than 20% reduction in cell viability.

Concentrations of 20 mg/ml in concentrated leaf extract and essential oils were both within the predicted range since they did not cause a 20% or greater reduction in cell viability and were thus not cyto-toxic. Results for the cell viability showed no influence at concentrations below 20 mg/ml (Yamani et al., 2016). Zones of inhibition were discovered using a disc diffusion experiment across both Gram-positive and Gram-negative organisms; how- ever effect against S. aureus was stronger than against Gram-negative species (Mahmood et al., 2008). Both Gram-positive and Gram-negative species were effectively suppressed, as demonstrated by a drop in optical density, while P. aeruginosa slightly outperformed S. aureus in these test conditions (Mishra and Mishra, 2011). In tests against P. vulgaris, S. aureus, P. aeruginosa, and E. coli, Tulsi essential oil from one subspecies of *O.tenuiflorum* performed better than extracts from two other subspecies of Tulsi (Helen et al., 2011).

Gastritis and liver issues are treated with a decoction of the leaves. To treat dysentery, patients are often given the juice of fresh leaves. An Ocimum suave methanolic extract was shown to treat chronic stomach ulcers in experimental mice, according to a research. Oci- mum sp. is anti-malarial, and so are pepper, turmeric, and onion. Larvicidal and insecticidal effects of oilbisabolene (13-20%), methyl chavicol (3-19%), 1,8-cineole (9-33%), eugenol (4- 9%), (E)--bisabolene (4-7%), and -terpineol (1.7-7%) are the main components of tulsi oil. In Indian gardens, tulsi is frequently used as a mosquito deterrent. The essential oils from tulsi are totally larvicidal. Additionally, it has been shown that tulsi has amazing anti-malarial properties (Singh et al., 2010).

The primary component, eugenol, is what gives the product its repelling properties. A paste produced from Tulsi leaves is used to cure ringworm infection. Tulsi is effective against parasites and worms. It has been demonstrated that Tulsi leaves possess strong antifungal activities against Aspergillus species. Ocimum has strong antibacterial activity against Vibriocholerae, E. coli, Proteus and Staphylococcus aureus, Klebisella (a bacterium that causes pneumonia and urinary tract infections), and E. coli (Chiang LC, 2005).

Additionally, it has been demonstrated that *O.tenuiflorum* possesses antiviral properties against Bovine Her-pes Virus 1. It is believed that Ocimum sp. essential oils, which contain eugenol, carvacrol, methyl eugenol, and caryophyllene, are principally to blame for the variety of antibacterial activities. One of the main components of tulsi leaves is ursolic acid, which has been said to have anti-fertility effects. Its anti-estrogenic activity, which may be to blame for male spermatogenesis arrest and female ovum implantation suppression, has been related to this effect.This ingredient might work as a safe anti-fertility medication. Tulsi leaves reduce the activityof sertoli cells, which prevents male spermatogenesis (Prakash P, 2005).

2.2.4 Components of O.tenuiflorum

Tulsi extends life span amid anoxic stress and has an antihypoxic effect. In exper- iments on rabbits, tulsi has been found to lessen oxidative stress. Previous studies on the Ocimum genus revealed a wide range of polyphenolic chemicals, and the deep purple color of the flowers was closely related to the presence of several anthocyanin types. There have also been reports that the main caffeic acid derivatives in fresh basil leaves are other sub- stances, like chicoric acid (Lee and Scagel). GC and GC-MS were used to characterize the essential oils.For *O.tenuiflorum*, the main constituents were methyl eugenol (84.7%) and caryophyllene (7.4%), while for O. basilicum, they were linalool (35.1%), eugenol (20.7%), and 1,8-cineole (9.9%).

O.tenuiflorum essential oil demonstrated a more dominant action against dermatophytes (0.32 L/mL) and C. neoformans (0.16 L/mL). For the first time, the impact of both essential oils on the formation of germ tubes was described, revealing that *O.tenuiflorum* can reduce the formation of germ tubes by more than 50% at concentrations four times lower than the MIC (Minimal Inhibitory Concentration), whereas O. basilicum can do so at concentrations eight times lower than the MIC. Additionally, O. basilicum demonstrated a more dominating impact on both the prevention of C. albicans biofilm formation and the destruction of existing biofilm (Piras et al., 2018).

2.3 Organic cotton

2.3.1 About Organic cotton

The textile and apparel industries are among the worst pollutants of the industrial sectors (Taljaard et al., 2018). Only agriculture scores higher in India than the textile industry. Textile

remains one of India's oldest industries, accounting for about 14% of total production value addition, over one-third of gross export income, and engaging millions of people. The textile industry is quite important in our country. It was one among the first to develop in India, accounting for 14% of total industrial output, 30% of all exported goods, and the second largest employment after agriculture. None knows where the very first cotton cloth was manufactured (Oh, 2016).

2.3.2 History of Organic cotton

Archaeologists have unearthed evidence that people used to weave cotton as much back as 4,000 years ago in India, Central and South America. And we are aware that by 1500 A.D., cotton was being cultivated throughout the Americas, Eurasia, and Africa. Organic cotton is cultivated using ecologically friendly procedures and materials. Organic agricultural practices restore and protect soil fertility while limiting the use of toxic while persistent pesticides and fertilizers and promoting biological variety. Third-party certification groups verify that organic farmers use only certified organic production processes and ingredients. Organic cotton is grown avoiding the use of toxic and persistent pesticides or synthetic fertilizers.

Until the late 18th century, cotton was grown, harvested, ginned, spun, and woven entirely by hand. Cotton cloth was only accessible to the wealthy. Only twenty years later, Sir Richard Arkwright's water-powered spinning machine and Eli Whitney's cotton gin altered everything. The cotton gin, a hand-cranked machine that separated the plant's fibers from its seeds, allowed an employee to clean fifty pounds of cotton each day instead of one. Following the invention of the cotton gin, the United States ascended to become the world's main supplier of cotton fiber (Oh, 2016).

2.3.3 Importance of Organic cotton

An online survey was designed to examine the variables, which comprised experimental choice-based collective models for compulsory and auxiliary label needs. Four hundred ninety-eight people completed the survey. Participants with moderate to high levels of awareness were willing to buy organic cotton items at more expensive rates and had a favorable opinion on organic cotton apparel than respondents with low levels of knowledge, according to the findings. The findings show that while assessing organic cotton garment items, buyers with differing degrees of skill may pay attention to different forms of information offered on product labels (Oh.et.al, 2016).

Turkey and the United States created the first certified cotton in theearly 1990s.By 2006, 22 countries had cultivated organic cotton, and worldwide trade had quadrupled from 2001 to 23000 tones. More than 20 countries currently use more than 100 tones of certified organic cotton per year, with two-thirds only starting to sell organic textiles and clothing after 2002. Wallmart, Nike, and Coop Switzerland are among well-known retailers of organic cotton products. Cotton fiber handled in the international cotton market amounts up about 0.09% of the 24.8 million tones was trading overall (Peter.et.al, 2008).

Patagonia, a high-end outdoor clothing maker, began utilizing organic cotton throughout all its sportswear (i.e., casual gear for travel and leisure) in 1996. Customers were willing to pay significant premiums for organic cotton clothing despite knowing that there weren't any evident personal benefits to the client (Casadesus-Masanell et al., 2009).

To obtain data, aweb-based survey of 200 female South Korean individuals over the age of 18 was employed.Perceived benefits, the importance of one's own voice via appearing well, risk of performance, risk to finances, and subjective standards all had a significant impact on people's views aboutobtaining organic cotton garment items, based with the results of SEM. Additionally, riskto finances, attitude, and subjective standards all had a significant influence on customers' purchase intent. Subjective norm was revealed to have a major role in the purchasing process: of the six variables tested, subjective standards was one of the biggest antecedents of attitude and had a comparable influence on intention to purchase as attitude (Han.et.al, 2014).

The increased popularity of clothing made of organic cotton in the fashion sector mayhave a substantial influence on contamination in the garment and ecological sectors, as well as opens out fresh opportunities for eco-friendly clothes. Concerns regarding the environment and consumer attitudes, depending to the study's conclusions, have a positive impact on Bangladeshi customers' willingness to purchase OCC. likewise; the authenticity and trend of OCC goods have a large effect on the purchase intents of Bangladeshi customers. Product Performance revealed an indirect impact on Bangladeshi consumers' intention (Hasan et al., 2022).

Humans employ natural materials present in the environment to protect our bodies from the elements and for other societal functions. These natural materials are now employed in a variety of goods and have a variety of uses. Cotton is the most well-known fiber and the

most extensively utilized raw material in the textile industry. Except for a few synthetic fibers, this sector is dependent on various varieties of cotton. Cotton is obtained through our agricultural system. Many things are engaged in our agricultural system now that have major environmental consequences. Our cotton use grows year after year, with global cotton consumption increasing by 2.66 percent in the 2021-22 seasons. Cotton farmed naturally has no negative environmental impact unless fertilizers, pesticides, and other toxic chemicals are employed.

2.3.4 Properties and characteristics of Organic cotton

However, the usage of rapidly expanding cotton and the manufacture of conventional cotton fiber with various chemicals today affect the land, water, and air, leading to environmental degradation (Ali, 2013). Organic farming practices provide a more secure, environmentally friendly and non-harmful environment; organic fertilizers, organic pesticides, and insecticides are employed (Ul Hasan et al., 2021). Organic cotton is thus far superior for customers, farmers, and all organisms (Kumar, 2018).

The present global population is 7.8 billion, according to the US Census Bureau, with UN DESA predicting 8.5 billion by 2030 and 9.7 billion by 2050 ("The World Population Prospects: 2015 Revision"). According to existing solutions, people will need to use more textile and cotton, and demand will rise. One of the most difficult challenges is the increasing temperature and climate change, which are directly related to CO2 emissions (Ali, 2020). Textile industries emit between 1.22 and 2.93 billion tones of CO2 into the atmosphere. Cotton has a significant carbon footprint, ranging from 2-4 tons per hectare.

Organic cotton, on the other hand, has 40% less "global warming potential" and implies a 91% reduction in natural water usage when compared to standard cotton. In this circumstance, we are certain that organic cotton clothing practice may be one of the best answers for this business, making it more sustainable and ecologically beneficial. Not just in affluent nations like the United States, but also in underdeveloped countries like Bangladesh. Plenty of recent research on environmental sustainability and the ecologic movement have been conductedin Western industrialized countries with little regard for poor countries like Bangladesh (Ul Hasan et al., 2021).

Sustainable fashion practice provides a solution to several environmentalissues associated with fashion production and consumption (Hasanspahic). According to re- cent research on

customer propensity to purchase behavior, increased knowledge and environmental concerns affected consumer purchasing decisions on organic apparel cotton (Gam et al., 2010). We think that by their shopping habits, customers can influence the movement of fashion firms towards sustainability. Furthermore, the fashion sector should be cognizant of environmental and human safety issues, as well as other noteworthy corporate social duties. According to a poll of European consumers, fashion firms should take on the problem of climate change and environmental conservation (Ul Hasan et al., 2021).

2.3.5 Use and applications of Organic cotton

Consumer willingness is affected by a variety of factors; evidence from prior studies summarizes that high product costs, a lack of variety, aesthetic challenges, legitimacy of data, and ambiguity concerning truly ecological advantages were the main barriers to purchasing environmentally friendly goods, including clothing (Abrar et al., 2018). The need of consumers especially green products is also linked to pricing and income strategies, particularly for green items supplied at a greater price than conventional products on the market. However, environmentally conscious customers are on the rise, and many are willing to pay a premium for ecologically friendly items. Boks and Stevels indicate that consumers are willing to buy green products when their income and budget increases. A study on organically grown products (OGPs) already proved that monthly household income is statistically significant and positively influences the consumer purchase intentions of organically grown food products (Gam et al., 2010).

2.4 Fabric production

Weaving, in particular, and fabric manufacturing in general, are possibly as old as documented human history. One of the first things that early people need was a piece of fabricto cover their bodies for modesty and to protect themselves from the damaging effects of the environment.

Weaving is a combination of science and art. Even with all of the technological advances, weaving is still not a strictly regulated process. That is, the individual fiber, the smallest important building element in a woven structure, is difficult to control. Because of this, weaving is a fascinating technology. Fibers are mostly utilized in the manufacture of fabric. Natural fibers are composed of both plant and animal fibers. After the fabric is created, it is frequently treated and/or dyed, changing the properties of the raw cloth for the intended use.

Weaving, braiding, knitting, tufting, and the creation of non-woven materials are among the most often used methods for creating fabric. During weaving, warp and filler threads are woven together perpendicularly. There are almost unlimited combinations of techniques to interlace warp and filler yarns. Each technique yields a distinct fabric structure. Each of these fundamental techniques for fabric production yields a different architecture. Large businesses have emerged thanks to virtually every fabric production technique in every country on earth.

Around 40 countries have sizable textile industries, while another 50 countries pro- duce woven textiles in variable quantities. Over 70% of all fabrics produced globally are woven textiles.

There are several ways to classify woven fabrics:

1. Classifying according to the kind of weave, such as plain, twill, satin, leno, etc.
2. Grouping by terminology that is often used, such as percale, denim, and cheesecloth.
3. The classification of fabrics into heavy and light groups according to weight.
4. Classifying items according to how they were colored, such as stock dyed, solution dyed,or colored yarn or pieces.
5. Classification of end- uses: textiles for commercial, residential, and apparel applications

(Adanur, 2000).

2.4.1 Plain weave

Plain weave is the most basic kind of weaving. Below, the warp and filler threads are knotted together one over the other. Because the basic weave formula repeats on two warp and two filler yarns, the fabric's top and bottom sides have the same texture. For plain weave,only two harnesses are required. However, it may be woven on more than two harnesses if the warp density is more than 50 ends per inch (EPI). Frequently, four harnesses are used to weave it. Because of the 1/1 interlacing, the basic weave has the most yarn crimp in its struc-ture. The plain weave thus has a low modulus in comparison to other designs with less crimp in their structure.

The warp rib formula has a different interlacing pattern in the warp direction from the 1/1 interlacing in the filling direction. The filler yarns are grouped together to create a pattern that gives the fabric ribs or ridges in the warp direction. Two warp yarns are present in ev- ery warp

rib repetition unit. The first warp follows the formula exactly, but the second warp deviates from it. Therefore, any warp rib design requires a minimum of two harnesses. The number of filler yarns in the repetition unit is represented by the sum of the digits in the warprib formula. Warp rib formulas come in two flavors: regular and irregular. The numerator anddenominator of a regular or balanced warp rib formula are the same number, for instance, 2/2,3/3, etc. In an irregular or unbalanced formula, the digits can be any number, such as 2/3, 4/2,2/3-3/3, etc. The design still seems to have uneven ribs even if just a fraction of the numeratorand denominator of the equation have the same value.

The filling rib formula differs significantly from the 1/1 interlacing of the warp direction in the filling direction. Ribs or ridges that run across the fabric in the direction of the filling are therefore included in the pattern. These ribs are a result of the grouping of warp yarns. Like the warp ribs, all filling ribs have two filler yarns in the repetition units. The first filling follows the formula, while thesecond filling does not. Therefore, any filling rib design requires a minimum of two harnesses. The number of warp yarns in the repetition unit is represented by the sum of the digits in the filling rib formula. Both regular and irregular rib filling formulas are applicable (Adanur, 2000).

2.4.2 Twill weave

The twill weave is produced in a stepwise sequence by the interlacing pattern of the warp yarns. Following the same guidelines, each warp yarn starts its interlacing pattern on a different filler yarn. As a result, the fabric creates a distinctive diagonal line for this design known as the Twill line. Instead of being a literal line, the twill line is an imprint made by the design's interlacing, which happens in phases. Depending on how the twill line is oriented, the weaves are either right-hand or left-hand twills.

Right-hand twill has a twill line that runsfrom lower left to higher right. In left-hand twill, the twill line runs from lower right to upperleft. A fabric with right-hand surface twill has left-hand twill on the reverse. Regular and irregular twill weave formulations are both available. The number of numbers in a regular or balanced twill formula is always the same, as in 2/2, 3/3, 4/4, etc. A formula with irregularor unbalanced digits has distinct numbers for the digits, such as 1/3, 4/2, 2/3-3/2-1/1, etc. Theformula's digit sum yields the unit cell of the pattern as well as the bare minimum numberof harnesses required to weave the pattern (a twill weave requires at least three harnesses) (Adanur, 2000).

2.5 Pre-treatment of fabric

2.5.1 Desizing

Natural impurities as well as 'size' that was added to the cloth to ease weaving can be found in grey cotton fabrics. When weaving is being prepared, a technique known as "sizing" adds the size to the gray cloth. Desizing is the method used to eliminate the extra substanceor size from the cloth. Desizing is the process of removing sizes from warp threads that were added for reinforcement during the weaving process. Starches or other synthetic chemical substances, such as polyvinyl alcohol (PVA), are typically used to make sizes. Sizes are often removed using time-consuming, environmentally damaging chemical processes such acid steeping, alkali steeping, and oxidative treatment. Today, using biological enzymes that break down and digest the size, especially starch-based ones, is a more efficient and quick way. The enzymes are then eliminated together with the disintegrated size residues using a series of hot and cold water rinses (textile blog, 2022).

2.5.2 Scouring

An all-natural fiber is cotton. It does, however, have a variety of organic and synthetic contaminants. In order to make the cloth cleaner and more absorbent for the dyeing and printing process, it is crucial to remove both natural and artificial impurities from it.

Cleaning cotton fabrics with scouring removes impurities like dust, wax, oil, and other residues and opens up the fibers to make them more absorbent during the dyeing process. This scouring procedure is also carried out using a variety of equipment and methods, including mechanical agitation, chemical treatments, and treatments with enzymes and acids.Natural wax and non-fibrous impurities, extra soiling, or dirt are removed from cotton fabricsusing scouring, a chemical treatment method. The cotton fabric scouring procedure uses kiers, which are substantial iron vessels (Zillane Patwary, 2023).

2.6 Finishing

Any procedure that enhances a fabric's aesthetics or functionality after it comes off the loom or knitting machine might be regarded as a finishing phase. The final stage of fabric production, finishing, is when the fabric's final characteristics are created.

In its broadest definition, the phrase "finishing" refers to all operations that textiles go

through after being created on looms or knitting machines. It is the third and last stage of processing after bleaching and dying, however in a more constrained sense. When the cloth is neither bleached nor colored, even this definition may not be applicable. Finishingis the series of procedures that textiles are put through after coming off the loom or knitting machine, excluding scouring, bleaching, and coloring. The majority of finishes are used on knit, non-woven, and woven materials. However, finishing can also be done on clothing or yarn (for instance, silicone finishing on sewing yarn). Finishing is typically carried out on cloth rather than yarn. However, finishing in yarn form is necessary for sewing threads made of mercerized cotton, linen, and their blends with synthetic fibers, as well as some silk yarns (Roy Choudhury, 2017).

2.6.1 Kinds of finishing

The finishing techniques may be roughly divided into two categories:

- Physical/mechanical
- Chemical

Simple procedures like drying on a steam-heated cylinder to different types of calendars, rising for soft effects on the surface of the fabric, and breaking the finishing of filled products for a comfortable feel are all included in physical or mechanical operations. Few changes have been made to the majority of mechanical finishes since their invention in antiquity. Chemical finishing can enhance some physical attributes, such as dimensional stability. Dry finishing, also known as mechanical finishing, affects the fabric's qualities primarily by physical (particularly mechanical) processes, often also changing the fabric's appearance. Calendering, emerising, compressive shrinkage, elevating, brushing and shearing, or cropping is some of the mechanical finishes. Wool textiles can be mechanically finished by milling, pressing, setting, crabbing, and decatising. Thermal finishing, often known as mechanical finishing, includes thermal processes like heat setting. Despite the fact that good fabric processing frequently requires moisture and chemicals, mechanical finishing is still regarded as a dry technique.

Adding chemicals to textiles in order to achieve a desired outcome is known as chemical finishing or wet finishing. Water is utilized as the application medium for chemicals in chemical finishing. Heat is used to activate the chemicals and drive off the water.

The development of fresh finishes has been ongoing, and the chemical processes have altered dramatically over time. To enhance the impact, several chemical techniques are used with mechanical techniques like calendrizing.

After chemical finishing, the cloth often retains its original look.

Physical finishing:

1. Optical finishes
2. Brushing and napping
3. Compacting (Roy Choudhury, 2017).

2.6.2 Functional finishing

Functional finishes:

Using the appropriate chemical and/or physiochemical techniques, various functional fabric properties can be improved. The latter rapidly supplant traditional wet chemical techniques and include coating and exposure to high-energy sources. To concurrently increase several functional qualities, polymers are increasingly used in place of basic compounds. Fabrics and fibrous materials have their characteristics changed to enhance their resistance to different physical, chemical, and/or biological agents and influences. These modifications to a material's properties include resistance to wrinkling, fire, soils and stains, water, microorganisms and insects, light, heat, and cold, shrinkage, air pollutants, chemical agents, mechanical changes brought on by abrasion, pilling, and various types of deformation, as well as the accumulation of static electricity.

The following list includes a few finishing procedures that enhance the functional textile characteristics as well as the suitability or demand for various fiber types:

1. Resiliency or wrinkle resistance for cellulosic fibers and mixes with synthetics.
2. Flame retardancy—most synthetic and natural fibers.
3. Absorbency—typically used to give synthetic fibers a hydrophilic quality.
4. Soil release—primarily for blended synthetic fibers.
5. Soil and stain repellency—primarily for synthetic fibers.
6. Water repellency—primarily for fibers made of wood.
7. Microorganism resistance—primarily for cellulosic fibers, all fibers used in medicine.

8. Insect resistance—mostly for wool fibers.
9. Shrink proofing—most often used with wool and cellulosic fibers.
10. Static charge resistance, especially for synthetic fibers.
11. High tenacity synthetic fibers and their mixes exhibit resistance to pilling.
12. Resistance to abrasion and wear—primarily for mixes of cellulosic fibers.
13. The majority of natural and synthetic fibers, particularly polyamide fibers, exhibit resistance to UV radiation, heat, and pollution.
14. All natural and synthetic fibers have the same thermal conductivity (warmth or coolness, thermal comfort).

Functional finishes are applied to textile materials using physicochemical or chemical processes. The former comprises coating, insolubilization or deposition, high energy application or irradiation, and microencapsulation. Covalent formation, ion-exchange/chelating,resin treatment, and polymerization are some chemical techniques (Roy Choudhury, 2017).

2.7 Antimicrobial finish

Textile researchers and manufacturers face several obstacles as global competitiveness intensifies. The fast rise of technology fabrics and their applications has created several opportunities for the use of new finishes. A more sophisticated and demanding consumer market appreciates novel treatments with significant added value for garment textiles. Anti-microbial textiles with increased functioning have a wide range of uses, including health and hygiene items, particularly clothes worn near to the skin, and various medical applications, including infection control and barrier material. With the advancement of new antimicrobial fiber technologies and the growing awareness of cleaner environments and healthy lifestyles, a variety of textile products based on synthetic antimicrobial agents such as triclosan, metal and their salts, organometallics, phenols, and quaternary ammonium compounds have been developed and are commercially available.

Although synthetic antimicrobial compounds are particularly efficient against a wide range of bacteria and have a long lasting impact on textiles, they are a source of worry owingto the accompanying side effects, non-target microorganism activity, and water contamination. As a result, there is a high demand for antimicrobial textiles based on eco-friendly agents that not only serve to effectively decrease the bad effects associated with microbial development on

textile material but also meet with statutory standards set by regulatory bodies. Natural ingredients such as chitosan and natural dyes have been widely used for antimicrobialfinishing of textile textiles. Other natural herbal remedies that can be used for this purpose include Aloevera, tea tree oil, Eucalyptus oil, and tulsi leaf (Ocimum basilicum) extracts. There are several therapeutic plants with potent antibacterial compounds.

Despite the fact that many natural ingredients are abundant in antimicrobial com- pounds, relatively little research has been done on how these materials might be used in textiles. Herbal products can be used as an appealing environmentally acceptable substitute for synthetic antimicrobial agents in textile applications due to their cheaper cost and relative lower incidence of adverse responses when compared to contemporary synthetic medicines. New directions in this field of study have been made possible by recent advancements in plant-based bioactive compounds. The majority of studies in this field focus on the technical aspects of using certain natural agents—like neem extracts, natural dyes, chitosan, and other herbal products—on textile substrates and evaluating them.

On the other hand, the other review articles in this field of antimicrobial textiles ad- dress a variety of antimicrobial agents, most of which are synthetic and just a few of which are natural. There isn't a review that focuses solely on natural ingredients and how to use them to give fabrics an antibacterial effect. As a result, a thorough critical analysis of the natural product-based antimicrobial finishing agents for use on textiles has been published inthis work.

Along with the significant difficulties and opportunities for further study in this specialized field, a thorough compilation of the various classes of active components identified in extracts of natural products and their mechanisms of antimicrobial activity has also been provided.

The majority of all natural antibacterial agents come from plant sources. Since ancient times, various plant materials have been employed for their healing properties. On Earth, there are thought to be between 250,000 and 500,000 different plant species. One to ten per- cent of these are consumed as food by both people and other animal species. More than this could have therapeutic qualities. Hippocrates recorded 300–400 therapeutic plants in the late fifth century B.C... Additionally, plants possess an almost infinite capacity to produce aromatic compounds, the majority of which are phenols or their oxygen-substituted counterparts. The majority of them are secondary metabolites, of which at least 12,000 (less than 10% of the total) have been

identified.

These compounds frequently act as defenses for plants against herbivores, insects, and microbial predators. Terpenoids, for example, are responsible for the smell of plants, whereas quinones and tannins are in charge of the color of plants. The flavor of plants is caused by a variety of substances, including the terpenoid capsaicin found in chilli peppers. Some of the herbs and spices that people use in their diet also contain beneficial medicinal components.

Tannins are water-soluble polyphenols that are naturally present in many plant species, including trees. They can build up in portions of plants like bark, wood, leaves, roots,or fruits up to 10% by dry weight. Tannins have antibacterial properties that are effective against a variety of bacteria and fungi.

The leaves of Ocimum sanctum Linn are used to make tulsi (Osmium basilicum), which is a member of the Labiatae family. The main components are Eugenol (which makes up 70% of tulsi), methyl eugenol (20%), carvacrol (3%), and caryophylin, etc. Tulsi leaves have been utilized for antibacterial, insecticidal, antiprotozoal, diaphoretic, expectorant, and aromatic carminative purposes since very early times. Further, noticing that tulsi leaves with antibacterial properties are appropriate for use in textiles. Tulasi leaf methanolic extracts were applied to cotton fabric using the dipping technique. Despite tulsi's lack of action in theirinitial investigation, a challenge test revealed a 73% reduction in germs. Tulasi oil's abilityto resist bacteria has also been investigated. It was added to size paste as a size preservative for use on cotton yarn in leaf form, however from the perspective of strength preservation; storage of the sized leaves did not show any promising results (Sarkar et al., 2016)

The many natural antimicrobial agents' bactericidal mechanisms are yet unclear. Because the majority of the items are not soluble in water, the dissolving of the agents for textile application is another significant difficulty.

Another emerging area of study is the attachment of bioactive chemicals to various kinds of complex textile substrates for extended durability of the antibacterial action. The design of bioactive textiles with delayed release mechanisms for extended activity will be a good field of advances in the world of biotextiles, despite the limited research that has been done on the production of natural agents encapsulated goods (such as microencapsulated neem oil).

Some natural compounds have a very strong and unpleasant odor that may create mental

sickness in the user, which should be considered before placing those chemicals on textile substrates. The physical and other performance attributes of the treated fabrics must also be preserved during the antibacterial process. For example, after coating the textile surface with chitosan, the air permeability of the fabric is limited, that eventually impacts the comfort of the users. Other essential functional and physical attributes, including as bending rigidity and bending modulus, which directly impact fabric stiffness and drape characteristics, should notbe affected by antimicrobial treatment. The blockage of active functional groups (which maybe responsible for their antimicrobial activity) during textile attachment may result in a loss of bioactivity on textile surfaces (Joshi et al., 2009).

In the future, antimicrobial fabrics could help treat and prevent wound infections. Oneof the main causes of wounds that do not heal is infections. It is vital to lower the amount of bacterial load to enhance the healing process because bacteria affect the balance of degradative and reconstructive processes during wound healing by amplifying and/or maintaining a pro-inflammatory milieu that prevents re-epithelization. Infections commonly involve mixed populations of aerobic and anaerobic bacteria, and the majority of chronic wounds are poly-microbial. Using Staphylococcus aureus as an example, it is known that these and other types of wounds have a high prevalence of this bacterium, which makes it the most troublesome bacterium in traumatic, surgical, and burn wound infections. Microbes, such as Pseudomonas aeruginosa, Escherichia coli, and bacteria Klebsiella pneumonia may potentially contribute to persistent wound infections (Paul, 2014).

2.7.1 Fungal development

Significant antibacterial action is shown in cotton that has been grafted with cyclodextrins, benzoic acid, or iodine as antimicrobial agents, especially against S. aureus and C. albicans. Metals, metal salts, and cat ionizing agents are the main antimicrobial types thatare used in the textile sector. The most typical application for them is as wound dressings. Microorganisms are very sensitive to copper because it may affect the conformational shape of proteins, membranes, and nucleic acids, displace other necessary elements within their native places of binding, hinder with oxidative phosphorylation and osmotic equilibrium, andreplace additional vital metals from their native binding sites.

Two methods are used to put textiles with odor-reducing qualities to use. One stops perspiration from degrading, while the other eliminates or compounds the chemicals produced

during degrading sweat. The microorganisms that live on the surface of human skin are eliminated using antibacterial compounds that are discharged from the textile's surface. Antibacterial polymer coatings made from a variety of materials have been employed. However, the natural population of microorganisms that reside on human skin is wiped out in this way. Other, more resilient microorganisms will take up residence in the open area. Therefore, from the perspective of dermatologists, this strategy may be harmful (Paul, 2014).

2.7.2 Bacterial development

The broth was used to visually modify the test pathogen colonies' turbidity to match a vortexes 0.5 McFarland turbidity standard after they had been transferred to the solidified agar plates using a swab. To remove excess inoculums, a sterile cotton swab was inserted into the inoculums and turned against the test tube wall over the fluid. To achieve a uniform distribution, the plates were rotated by around 60 degrees in between each streak of the cotton swab used to transfer the inoculums to the agar plate. The general process of inoculums preparation and culture medium inoculation remained the same for each of the pathogens studied (Mallikarjun et al., 2016).

2.7.3 Agar well diffusion method

Mueller Hinton Agar (BBL 211438 Becton Dickinson, Sparks, MD, USA) was layered to a depth of 4 mm in 90 mm diameter Petri dishes for the agar well diffusion tests of Enterococcus and Candida. Peptostreptococcus and Prevotella were grown on Brain Heart Infusion Agar (BBL 211065 Becton Dickinson, Sparks, MD, United States). The turbidity was adjust-ed to a 0.5 McFarland standard for E. faecalis and a 1.0 McFarland standard for Peptostrept coccus, Prevotella, and Candida using a direct colony suspension of each test isolate in 0.85% sterile saline.

The test suspension was splashed over the agar plates, and then a well (4 mm deep by 6 mm in diameter) was carved out of the middle. Each well received 50 L of the test drug or component using a sterile pipette. Prevotella tests were then incubated using a gas producing kit (Biomerieux, Mitsubishi Gas Chemical Company Inc, Japan) under anaerobic conditions for 48 hours at 35°C for Enterococcus and Candida Peptococcus. The sizes of the growth inhibition zones were measured using electronic callipers after a 48-hour incubation period, to the nearest 0.1 mm. Five times each experiment was run, and the means and standard deviations were computed (Athanassiadis et al., 2009).

To ensure an equal layer of cells on the agar plates, 50 L of the appropriate microbial inoculums was obtained using a micropipette. By evenly streaking the swab over the whole surface of the plate three times and rotating the Petri plates at around 60° after each application, the agar plates were infected with the appropriate bacteria.

The agar surface was then thoroughly swabbed all over. A total of 70 L of each medication and its corresponding vehicle were distributed into the four wells using micropipettes in a 1:1 ratio (i.e., 35 L medication +35 L vehicle) into five wells that were each 7 mm in diameter and 4 mm deep. The 5th well in the middle of the inoculated agar plate was supplied with undiluted medications or 70 L of antimicrobial drugs exclusively, and was regarded as the positive control. The plates were then incubated at 37°C for 48 hours anaerobically for P. gingivalis and for 24 hours aerobically for S. aureus, S. mutans, and E. faecalis. A scale in millimeters was used to assess the zone of inhibition on the Petri plates. To reduce mistakes, the tests were run three times (Bhat & Nalawade, 2016).

2.7.4 Exhaust dyeing method

The three distinct pigments were used to dye fabrics after they had been cat ionized by the selected procedure, employing 2% dispersion agent in one set, I g/L lubricating agent in another set, and all the leveling agents (2 gil) individually in the third choice. In the fourth option, Solid gal GL (2%) and I macol CI Liquid (I gil) were added to the dye bath. Without using a later binder, the dyeing outcomes on the two materials were assessed based on the levelness and depth of the colors.

METHODOLOGY

3 Methodology

The methodology of pertaining to the study entitled "**A Comparative study on Antimicrobial activity of *Ocimum tenuiflorum. Linn* leaves and stem extract on Organic cotton**" is discussed under the following side heading:

3.1 Selection of fibers

3.1.1 Selection of organic cotton

3.1.2 Selection of extract source

3.1.3 Properties of organic cotton

3.2 Manufacturing of fabric

3.2.1 Plain weave

3.2.2 Twill weave

3.3 Pre-treatment of fabric

3.3.1 Desizing

3.3.2 Scouring

3.4 Dye extract preparation

3.4.1 Water extraction method

3.4.2 Methanol extraction method

3.5 Finishing method

3.5.1 Exhaust Dyeing method

3.6 Evaluation

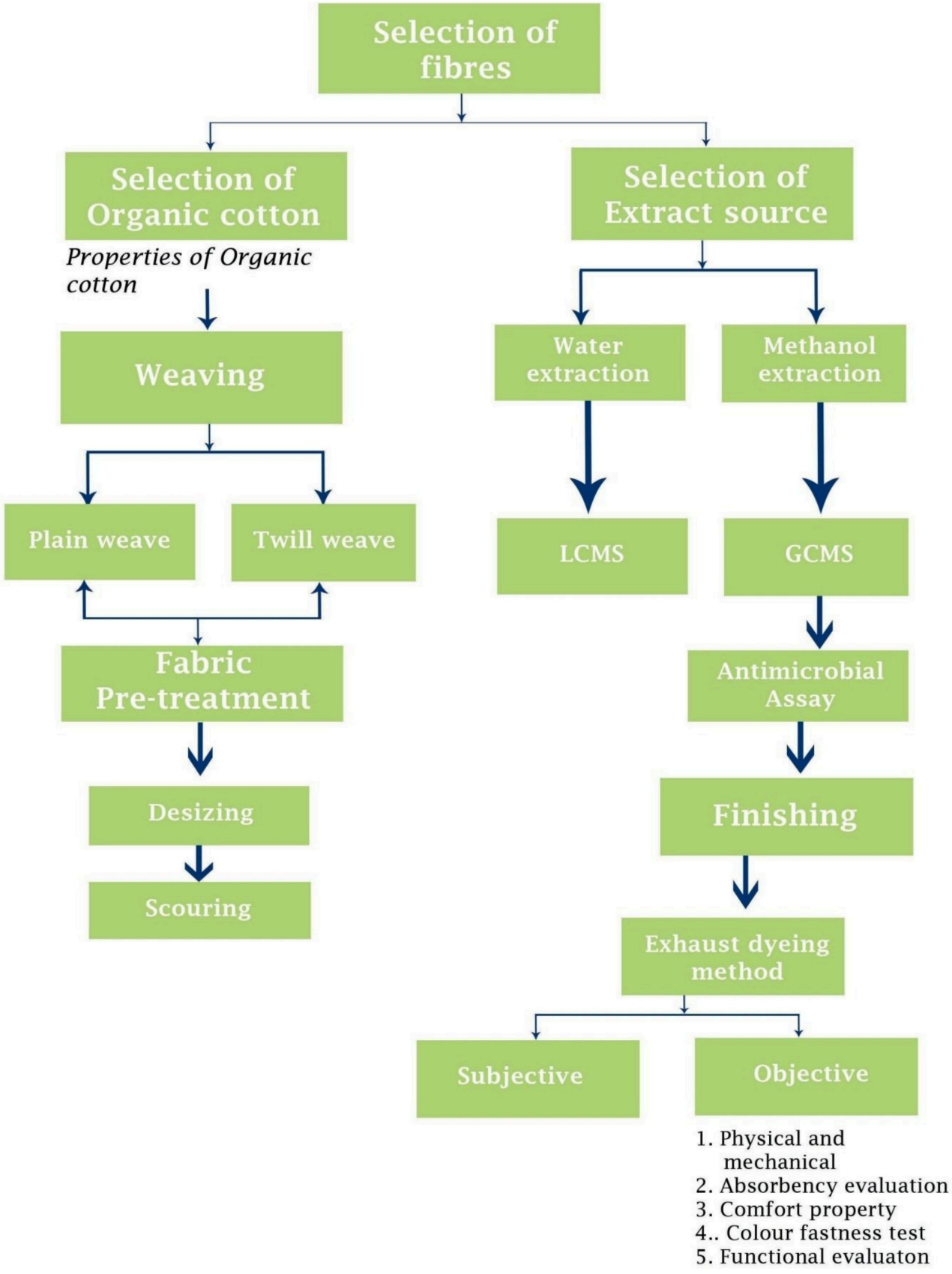
3.6.1 Visual inspection

3.6.2 Physical and mechanical evaluation

3.6.2.1 Fabric count

3.6.2.2 Fabric weight

3.6.2.3 Fabric thickness


Selection of fibres
Selection of Organic cotton
Properties of Organic cotton
Weaving
Plain weave
Twill weave
Fabric Pre-treatment
Desizing
Scouring
Selection of Extract source
Water extraction
Methanol extraction
LCMS
GCMS
Antimicrobial Assay
Finishing
Exhaust dyeing method
Subjective
Objective
1. Physical and mechanical
2. Absorbency evaluation
3. Comfort property
4.. Colour fastness test
5. Functional evaluaton

3.1 Selection of fibers

3.1.1 Selection of organic cotton

The yarn selected for further weaving is OE organic cotton yarn of 20s count from Sri jayajothi and company private LTD., 70, Alagai nagar, Rajapalayam – 626117 because given that it doesn't go through difficult manufacturing process, organic cotton is one of the most environmentally friendly options available when compared to other materials on the market. Due to the better soil quality, much less water is required for the manufacture of organic cot-ton fabric than conventional cotton.

According to life cycle analysis, producing cotton t-shirts using organic methods saves a whopping 1,982 gallons of water on average. The best choice is to choose organic cot-ton if you want to be more environmentally conscious and save natural resources. Although non-organic cotton crops only occupy 2.4% of the world's arable land, they consume 6% of all pesticides, so it is crucial to buy organic cotton whenever possible, according to Pesticide Action Network UK. (Galore, 2021).

3.1.2 Selection of extract source

The plant source selected for dye extraction is the *O.tenuiflorum* from the family of Lamiaceae, and belongs to plantae kingdom is known by many different names such as Geniosporum tenuiflorum (L.) Merr, Lumnitzera tenuiflora (L.) Spreng, Moschosma tenui-florum (L.) Heynh. The further sourcing of this species was from perayur, Thirumangalam. As there is growing data that shows tulsi's unique mix of pharmacological activities can relieve physical, physiological, metabolic, and psychological stress. Tulsi has been shown to protect organs and tissues against both chemical and physical stress, including that caused by extended physical activity, ischemia, physical constraint, exposure to cold, and excessive noise. Chemical stress is caused by industrial pollutants and heavy metals. Tulsi has also beenfound to combat psychological stress by improving memory and cognitive function, as well as metabolic stress by stabilization of blood glucose, blood pressure, and cholesterol levels, as well as metabolic stress through its anxiolytic and antidepressant characteristics (Cohen, 2014)

3.1.3 Properties of organic cotton

Tenacity: 25–40 cN/Tex, however wet materials can be up to 20% stronger.5–
10% elongation at break

Recovery that is rather inelastic. Just 45% of the way back after a 5% stretchLow resilience, but strong abrasion resistance (Yu, 2015)

Properties	Organic cotton	Regular cotton
Length (mm)	27.9	29.2
SFC (<16 mm, W%)	10.5	9.1
Uniformity ratio (%)	81.9	82.9
Fineness (dtex)	18.4	17.4
Micronaire (Mic)	4.9	4.5
Tenacity (cN/dtex)	2.7	2.8
Maturity ratio	1.65	1.8
Immature content (%)	6.8	6.3
Impurity (%)	1.7	1.1
Tenacity(cN/tex)	13.3	14.6
Weight variation (%)	1.39	1.13
CV of weight (%)	2.28	2.05
CV (%)	14.44	13.93
Thin place (Cnt/1000 m)	3	1
Thick place (Cnt/1000 m)	21	15
Neps (Cnt/1000m)	19	15

(Yu, 2015)

3.2 Manufacturing of fabric

3.2.1 Plain weave

A 1-1 weave is simply referred to as plain weave. The warp and weft are positionedto create a straightforward criss-cross pattern. This technique is one of the simplest and least expensive ways to weave cloth.

Weavers may make the final cloth tighter or looser, stronger or more breathable, by adjustingthe tension of the threads. A popular version of the plain weave technique is basket weave (Bryant, 2014). Calico or Tabby weave are two other names for the plain weave. With a repetition size of 2, it is the most straightforward of all weaves. The term “calico” or “tabby” weave are two different names for the plain weave. With a repetition size of 2, it is the most straightforward of all weaves. This weave has a broad variety of uses (School, 2010).

3.2.2 Twill weave

A balanced weave, such as a 2/2 twill, employs the equal number of warp and weftstrands to create the illusion of diagonal stripes. One warp thread is staggered in each row ofweaving, and all four rows of the pattern repeat are continually weaved to create the stripe. Wrap up a number of threads that multiplies by 4 to create a 2/2 twill, which repeats whenevery 4 warp strings and weft passes.

Under 2, Over 2, Under 2, Over in Row 1

Row 1 UNDER 1, then OVER 2, UNDER 2, OVER 2, UNDER 2

Row 2 UNDER 1, then OVER 2, UNDER 2, OVER 2, UNDER 2

Row 3 OVER 2, UNDER 2, OVER 2, UNDER 2

Row 4 OVER 1, then: UNDER 2, OVER 2, UNDER 2, OVER 2.

3.3 Pre-treatment of fabric

3.3.1 Desizing

Desizing is the process of taking the size out of the woven textiles' warp strands. Sizing agents are applied to warp yarns before weaving to lessen their frictional characteristics, minimize yarn breakages on the loom, and increase weft insertion speeds, all of which increase weaving productivity. In the wet processing of textiles, the sizing substance on the warp strands can function as a resist to dyes and chemicals. Therefore, it needs to be taken off before the cloth undergoes any further wet processing.

OBJECTS OF DESIZING:

- To get rid of the starch substance from the cloth.
- To boost the fabric's capacity for absorption.
- To improve the fabric's affinity for dry chemicals.
- To prepare the cloth for the upcoming procedure.
- Increase dyeing and printing to make the cloth more lustrous.

HYDROLYTIC METHODS - ROT STEEPING

The earliest and least expensive de-sizing technique is this one. Here, no unique chemical is employed. The material is initially squeezed to around 100% expressiveness in a padded mangle while being submerged in warm water at 40°C. After then, the fabric is left to stand for

24 hours. The naturally occurring bacteria in water proliferate and produce enzymes that liquefy (hydrolyze) the starch in the grain into water-soluble byproducts. After washing it, the product is removed from the fabric.

3.3.2 Scouring

All organic and accidental contaminants, including oil, wax, and fat, are eliminated during the scouring process to create clean, hydrophilic textile materials, particularly cotton. Cotton cloth goes through scouring as a finishing and coloring step. These contaminants pre-vent dyes and chemicals from reaching the inside of the fibers, increasing dye and chemical waste, and causing uneven dyeing due to poor scouring. It is a crucial step in the wet processing process.

Grey cloth often has three different types of contaminants: Waxy substances, proteins, minerals, and pectic substances Motes, leaves, and more mechanically retained contaminants Turn grease, waxes, and oils Tars, greases, oils, dirt, and dust from machines

Mineral Matter: 0.5% to 1% 85 to 96% cellophane 0.5%–1% of oil and wax Pectoses,3–5% of pectoses, and coloring matter

- Oils, fats, waxes, minerals, plant matter, and motes are a few examples of the impurities found in natural fibers that hinder them from being colored and polished.
- Synthetic fibers contain producer spin finishes, coning oils, and/or knitting oils. Textiles may be purified via scouring.
- While clothing is being created, contaminants including temporary fabric markings, mill dirt, and mill grease used to lubricate processing machinery may be present, sometimes re- ferred to as kiering, boiling out, or kier boiling.

3.4 Dye extracts preparation

3.4.1 Water Extraction method

The stems and leaves of *O.tenuiflorum* were obtained from in and around Perayur and it have been dried and grinded to smaller granules and heated in the dying bath with the boiling water of ratio 1:5 (100g extract and 500ml of water) and then the extract is filtered using whatmann's filter paper. The filtered extract is further kept for freeze drying at 4oC, later used for further analysis.

LCMS Analysis

The HPLC, in which a liquid is run down a column, is the first step in LC-MS. Components are divided in this column according to hydrophobic interactions, ion exchange, or other changeable traits. Because many compounds might share so-called retention durations, HPLC alone cannot be utilized for identification.

The duration needed for a solute to move through the column is known as the retention time.

Multiple components in a mixture can have this feature, which is why MS approaches are used. This produces a chromatogram that displays the retention time as a function of intensity (amount of component present). The components are transformed into an ionized state after being separated. The following phase entails separating the components based on the mass to charge ratio, which is a defining characteristic used by MS to distinguish components.

The chromatograms can be interpreted correctly in a number of different ways. It is challenging to come up with a universal solution for correct chromatogram processing since variables like LC separation characteristics, ionization techniques, and mass-to-charge ratio analyzers can all differ. The processing procedures will advance through phases when differential pro- filing, a technique that uses LC-MS settings to cover a wide variety of chemicals, is used.

The goal of spectral filtering is to remove noise from data, making it easier to spot peaks of interest. Noise reduction during LC-MS may also be optimized by employing shorter columns with lower particle sizes, among other approaches. Peak detection comes after filtering, and peaks signify components or component fractures. The peaks can be chosen depending on their height or the region they cover. Certain peak patterns can be determined visually by matching the present peaks to known ones. This can aid in determining the number of atoms or molecules present in the compound.

3.4.2 Methanol extraction method

PHYTOCOMPOUNDS CRUDE EXTRACTION - Methanolic maceration

The stems and leaves of *O.tenuiflorum* were obtained from the local region of Tamil Nadu. To achieve a constant dry weight, leaves and stems were dried in the shade for fiveto seven days at room temperature. In a shaker, coarsely powdered dry leaves and stemswere

pooled after being added with 100% methanol (20 gram/200 ml) for 24 hours at room temperature. In a distillation unit, the solvent in the supernatant was evaporated at 40 °C to produce the crude dried extracts of the leaves (0.134 gm) and the stem (0.120 gm)

GCMS Analysis

1 µl of crude extracts of leaves and stem (containing 1 mg/ml crude extracts in methanol) was used for GC-MS analysis. The QP 2010 Plus system, manufactured by Shimadzu in Kyoto, Japan, was used for the GC-MS analysis. It consists of an auto sampler (AOC-20i) and a gas chromatograph connected to a mass spectrometer at a temperature of 280°C for the interface and 250°C for the ion source. A threshold desorption system with a mass range of 50-650 m/z and ionization energy of 1000 eV was used for GC-MS detection. At a pressure of 53.5 kPa, the injection temperature was 280°C and the column oven temperature was 50°C. As a constant flow rate-total flow, helium (99.99 percent) was utilized as the carrier gas: Column flow: 54.0 ml/min 1.00 ml/min.

The GC-MS program took 30 minutes to complete. The Turbo mass software was used to analyze the mass spectra and chromatograms, and the average peak area of each component was compared to the total area to determine the relative percentage of each component. Data interpretation on mass range GC-MS was led utilizing the data set of National Institute of Standard and technology (NIST). The spectra of the known compounds in the NIST library were compared to the mass spectrum of the unknown compounds.

Antimicrobial Activity test

The in vitro antimicrobial activity of methanolic Tulsi stem and leaves extract was determined using the agar well diffusion method. Using a swab, colonies of test pathogens were transferred to the solidified agar plates and the broth was used to visually adjust their turbidity to match a vortexes 0.5 McFarland turbidity standard. A sterile cotton swab was plunged into the inoculums and turned against the wall of the test tube over the fluid to eliminate overabundance inoculums.

The inoculums was transferred by swabbing the agar plate two to three times with the cotton swab, and the plates were rotated by approximately 60 degrees in between each streak to ensure an even distribution. For each of the pathogens tested, the overall procedure of inoculums preparation and culture media inoculation remained the same. Five different

concentrations of the Tulsi leaves and stem extracts (5 mg/ml and 10 mg/ml) were inoculated into each bacterium on ten Muller Hinton agar plates.

Before creating wells for the various concentrations of tulsi extracts to be tested, the inoculated plate was allowed to stand for at least three minutes but no longer than fifteen minutes. A 1 ml micropipette tip was gently pressed above the inoculated agar plates to create a well with a diameter of 6 mm. By drilling a hole in the plate, it was immediately eliminated. Additionally, each plate had six wells, two each for the concentration of Tulsi extracts, a negative control (DMSO), and a positive control (Chloramphenicol 1 mg/ml for bacterial culturesand Amphotericin B for Candida albicans). Each well received the appropriate 100 µl of ex- tracts assigned to it. Within 15 minutes of applying the test samples, the plates were placed inan incubator and incubated at 37°C. Between 24 and 48 hours were spent incubating. Plates were read only if the growth lawn was confluent or nearly confluent after the incubation period. The inhibition zone's diameter was measured.

Thin Layer Chromatography (TLC)

The analytical TLC technique was used to count the number of phyto-constituents in the methanolic extracts of tulsi leaves and stem. With the aid of capillary tubes, the methanolic extracts of tulsi were spotted on the 0.25 mm pre-coated silica gel plates with a fluorescent indicator (F254) about 1 cm from the bottom edge of the plates and left to dry. Two solvent systems (Mobile phase) of hexane/ethyl acetate and hexane/ethyl acetate in the ratio of 4 : 1 and 3 : 2, respectively, were used. The 4:1 ratio: 1 (hexane/ethyl acetate) separated the components of the tulsi stem and leaf extracts the best. A 254 nm UV lamp was used to visualizethe dried plates. After that, the spots that had separated were marked, and the fronts of their samples and solvents were measured.

The following formula was used to determine the eluted spots' retention factor (Rf):

$$R_f = \frac{\text{distance travelled by spot}}{\text{distance travelled by solvent front}}.$$

3.5 Finishing the fabrics

3.5.1 Exhaust dyeing method

As for the final product the organic cotton yarn of 20's count is woven into plain and twill fabrics for further finishing of the herbal (*O.tenuiflorum*) extract on them. An exhaust dyeing method was used to bind the synthesized reactive herbal extracts (Stem and leaf) to the selected fabric samples (Sample-1 and Sample-2). The dye bath was prepared by adding 0.5ml of Triton-X-100, 100mg of sodium sulfate, and 5ml of the reactive herbal dyes to 10mL of de-ionized water.

To the suspension, cross-linking solution (citric acid) was added at a concentration of 2%. About one meter of fabric was submerged in the dye bath heated to 60°C. After 30min of incubation, 100mg of NaCl that had been dissolved in 10ml of de-ionized water was added. The temperature was then raised to 80°C, and the fabrics heated for another 30min. The fabric was then rinsed in de-ionized water and heated for 10min at 80°C in de-ionized water, then rinsed and kept in a convection oven at 105°C until dried.

3.6 Evaluation of finished fabric

To evaluate, the impact of the treated and untreated fabric samples. The samples were evaluated subjectively and objectively.

Subjective Evaluation

3.6.1 Visual inspection

The fabric samples that had been treated with *O.tenuiflorum* (Krishna Tulsi) were evaluated aesthetically by a panel of 30 Post Graduate students specialized in textiles and clothes.

Objective Evaluation

3.6.2 Physical and mechanical property

Physical characteristics are those that characterize the physical structure of textiles, and the tests that quantify these qualities are frequently referred to as characterization tests. Width, weight, number of fabric weights, and fabric thickness are examples of physical qualities.

3.6.2.1 Fabric count:

In pick glass method, the fabric is placed at the two different places randomly. Using pick glass and needle, the warp yarns and weft yarns per inch are counted from these phase readings

are calculated and mean value is calculated.

3.6.2.2 Fabric weight:

The equipment used for assessing fabric weight is GSM cutter. This is used to cut the fabric. Ithas sample cutter with safety catch lock. It has 4 replaceable blades. According to the ASTMD2646 standard, the pad is placed on smooth surface table, fabric is placed on the pad. The lock is removed by pulling and rotating the locking nut. The handle is pressed and rotated in clockwise direction. The fabric is gripped between cutter base and rubber pad for accurate cutting of fabric. The cut fabric is weighed using electronic balance. This value is multiplied by 100 to get GSM of fabric (obtained in gms).

3.6.2.3 Fabric Thickness:

As per the IS 7702 and ASTM D1777 the loading weight is placed on the weight pan specified pressure foot is fitted on mounting rod. Lifting lever is pressed and pressure foot topis lifted. The specimen is placed on the anvil and lifting lever is released gently. The pressure (downward) is applied on pressure foot on specimen. Reading of the dial gauge is noted to get specimen thickness in mm. This procedure is repeated for 10 samples and recorded. (Kothari, 2012)

3.6.2.4 Fabric Abrasion:

Ten specimens of 38mm diameter are fitted on the sample holders. The sample is unable to move vertically in the clamp. Sample holder and till more in the same plane in which the top plate shader.

Because of his movement, the cloth is rubbed against the cloth surface in hormones patter at one stage that will be circular and then changed to were of an equals until the line, straight line along the diagonal of the curve. Initial weight of the sample was noted, no. of times standard. After, the reading and abrasion was calculated and noted. Readings are taken and the mean value is calculated and rounded.

3.6.3 Comfort evaluation

3.6.3.1 Fabric Stiffness:

According to the standard of ASTM D1388 the instrument is placed on a table so that

horizontal platform and inclined references line are at eye level of the operation. The sample is held in horizontal plane and pushed along with the fabric specimen slowly and steadily. The fabric leading edges project beyond the platforms. The part of specimen will be over hang and start bending under its own weight. The eye is kept in such a way that the 2 inclined line of the tester coincide. The pushing of specimen is stopped when its tip reaches the level of inclined plane. If the specimen has a tendency to twist, the reference point at the centre of leading edge is considered. The length of overhanging is recorded for warp and weft separately. Ten readings for each specimen are taken from each side up, first at one end and then at the other. Five specimens in warp way and five in weft way are taken (Weissenbach, 2004).

3.6.4 Absorbency evaluation

3.6.4.1 Fabric wicking test:

As per the standard AATCC TM-197 the test specimen is suspended such that 20mm is immersed in the dye solution, after marking 20mm with incredible inks. This suspended fabric, depending on its absorbency property, exhibits the rise of liquid. The stop-watch is used to check the rise of liquid which is one minute. In one minute, the level of rise is noted in mm or cm, five such samples are tested and recorded (Ward man et al., 2011).

3.6.4.2 Fabric sinking test:

The specimen of size 25x25 mm, piece is cut and dropped on to the surface of distilled water at once the stopwatch is switched on. The time taken by the specimen to sink in water is recorded in seconds. If the sample does not sink within one minute, it is considered as having floated (Houck, 2009).

3.6.4.3 Moisture content and regain:

The test specimen is taken in a weight. This is kept in the hot air oven for 15 minute by adjusting the temperature till 120oC. Then the specimen is taken out, weighed and noted for finding the moisture regain. The specimen is exposed for an hour and reweighed.

3.6.4.4 Fabric Spray test:

According to the standard AATCC 22 and ISO 4920 the test specimen is fastened securelyin 125m metal loop which is wrinkle free. Distilled water of 250 ml is poured into the

funnel and allowed to spray onto the specimen in 25 seconds. The sprayed water deposits on the specimen. The loop is removed and tapped against solid object on the opposite side. This is repeated for 3 specimens.

The spray ratings are as follows:

100 – No sticking or wetting of upper surface.

90 – Slight random stitching or wetting of upper surface.

80 – Wetting of upper surface at spray points.

70 – Partial wetting of whole of upper surface.

50 – Complete wetting of whole upper surface.

0 – Complete wetting of both whole of upper and lower surface.

3.6.5 Color fastness test

3.6.5.1 Wet and dry crocking test:

The color fastness of a dyed fabric is asset by the samples of color from dyed fabric to another piece of un-dyed fabric while the fabric is used. Crock meter is used for accounting the fastness of dyed fabric under wet and dry conditions during rubbing. It consist of 2 metal blocks, the box blocks it stationary while the upper blockshas an arrangement to move and for the base by means of rotating handle. The color transfer from the dyed fabric to the material which is assessed with AATCC grey- scale for sustaining the procedure is followed to readings. The color fastness of the dyed material is to wet and crockering is carefully done.

Dry crocking – The same procedure was followed by crocking; under the fabric dyed condition the readings are recorded.

3.6.6 Functional evaluation

3.6.6.1 Anti-bacterial Assay

The test specimens (Sample-1 and Sample-2) were cut into pieces (20mm in diameter). SterileNutrient agar plates (Composition g/L: Peptone: 5g; Yeast extract: 5g, Beef extract: 3g, Sodium chloride: 5g, Agar 15 g); Final pH (7.0 ± 0.2) were prepared and allowed to solidify. Using sterile 4mm inoculating loop, one loop full of culture (Escherichia coli and Staphylococcus aureus) was transferred by swabbing all around the surface of the agar plate and

also covering the central area of the petridish. For each test organism, separate Nutrient agar plates were used in a sterile zone. All the inoculated plates were incubated at 37°C for 24 hours. The test plates were examined for the clear zone of inhibition around Sample-2 and Sample-3 separately. The average width of the zone of inhibition around each type of fabric specimen was calculated and presented in Table separately. The zone of inhibition was measured in millimeter (mm).

3.6.6.2 Anti-fungal Assay

The test specimens (Sample-1 and Sample-2) were cut into pieces (20mm in diameter). Sterile Nutrient agar plates (Composition g/L: Peptone: 5g; Yeast extract: 5g, Beef extract: 3g, Sodium chloride: 5g, Agar 15 g; Final pH (7.0 ± 0.2) were prepared and allowed to solidify. Using sterile 4mm inoculating loop, one loop full of culture (Candida albicans and Candida tropicalis) was transferred by swabbing all around the surface of the agar plate and also covering the central area of the petridish. For each test organism, separate Nutrient agar plates were used in a sterile zone. All the inoculated plates were incubated at 37°C for 24 hours. The test plates were examined for the clear zone of inhibition around Sample-2 and Sample-3 separately. The average width of the zone of inhibition around each type of fabric specimen was calculated and presented in Table separately. The zone of inhibition was measured in millimeter (mm).

3.7 Statistical Analysis

Statistical methods are employed to obtain more precise values. In this case, the information that is discovered is more dependable than the assumptions values. As a result, applying this statistical analysis decreases the possibility of creating incorrect values. The ANOVA approach is used to forecast the mean value and many other independent groups by comparing the pre-treated and dyed values of the samples. This approach was mostly used to determine whether the experiment findings were significant.

3.8 Nomenclature

PG - Plain weave Grey fabric
TG - Twill weave Grey fabric
PL - Plain weave Leaf extract
TL - Twill weave Leaf extract

PS - Plain weave Stem extract

TS - Twill weave Stem extract

Plate I: *Ocimum tenuiflorum* sample

Figure 1: Sri Jayajothi and company Pvt.

Plate II: Organic cotton yarn

Plate III: The yarn count of sample

Plate IV: Organic cotton yarn to be woven

Figure 2: Cotton flowers

Figure 3: Organic cotton flower (bursted)

Plate V: Warp of organic cotton

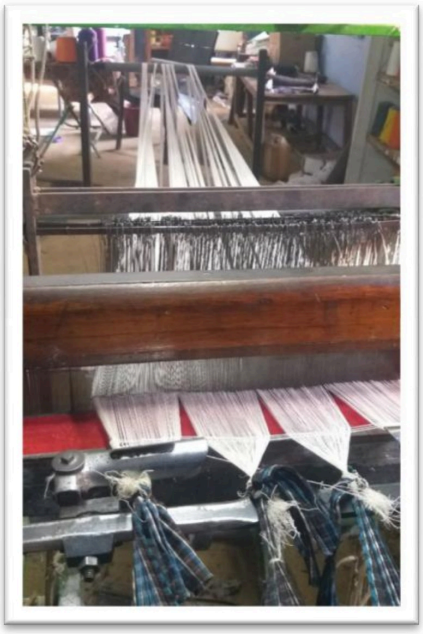


Plate VI: Yarns inserted into reeds

Plate VII: Yarns taken through heald shafts

Plate VIII: Warping preparation

Plate IX: The woven fabric desized

Plate X: Both plain and twill weave fabric are scoured

Plate XI: After drying both are iron pressed

Plate XII: Plain and Twill weave fabric samples.

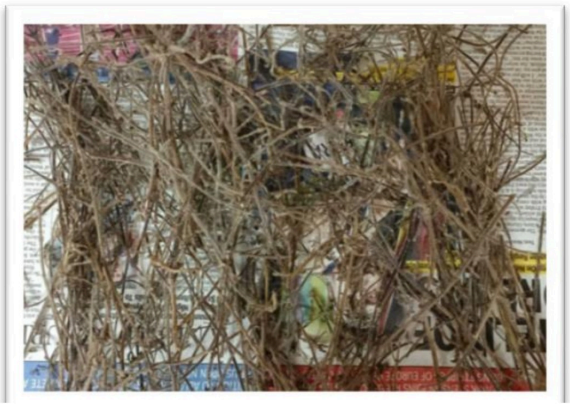


Plate XIII: Dried stem of *O. tenuiflorum*

Plate XIV: Dried leaves of *O. tenuiflorum*

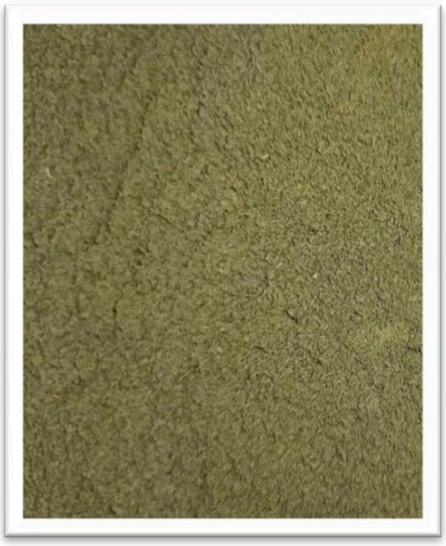


Plate XV: Powder of *O. tenuiflorum* leaves

Plate XVI: Powder of *O. tenuiflorum* stems

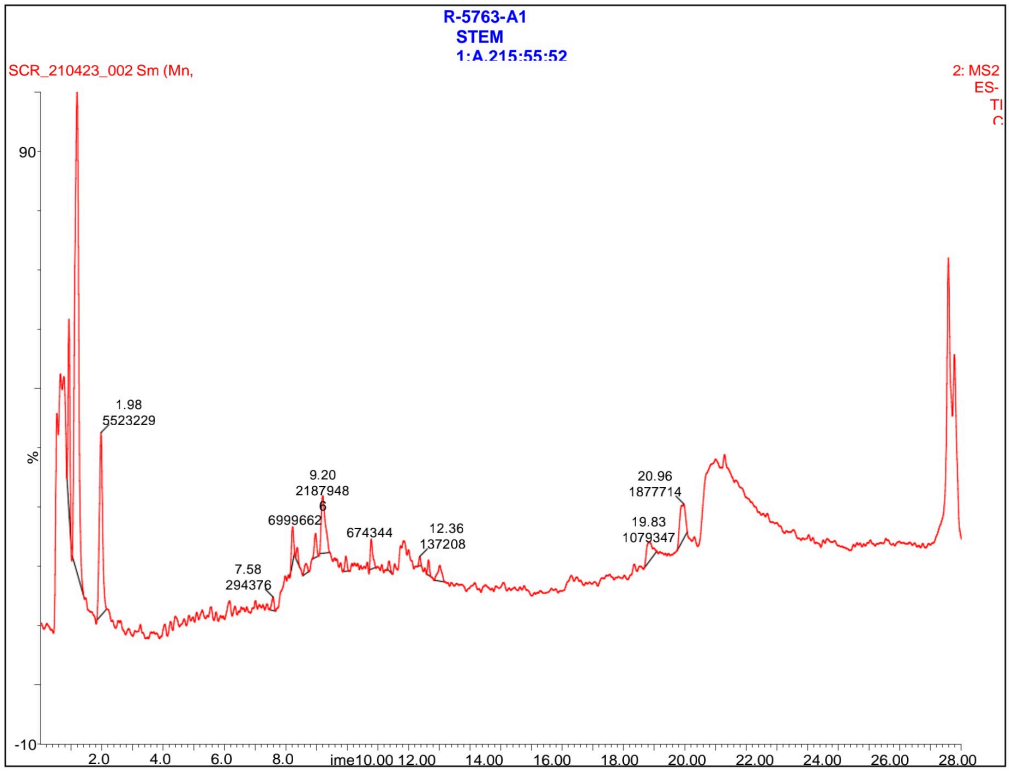
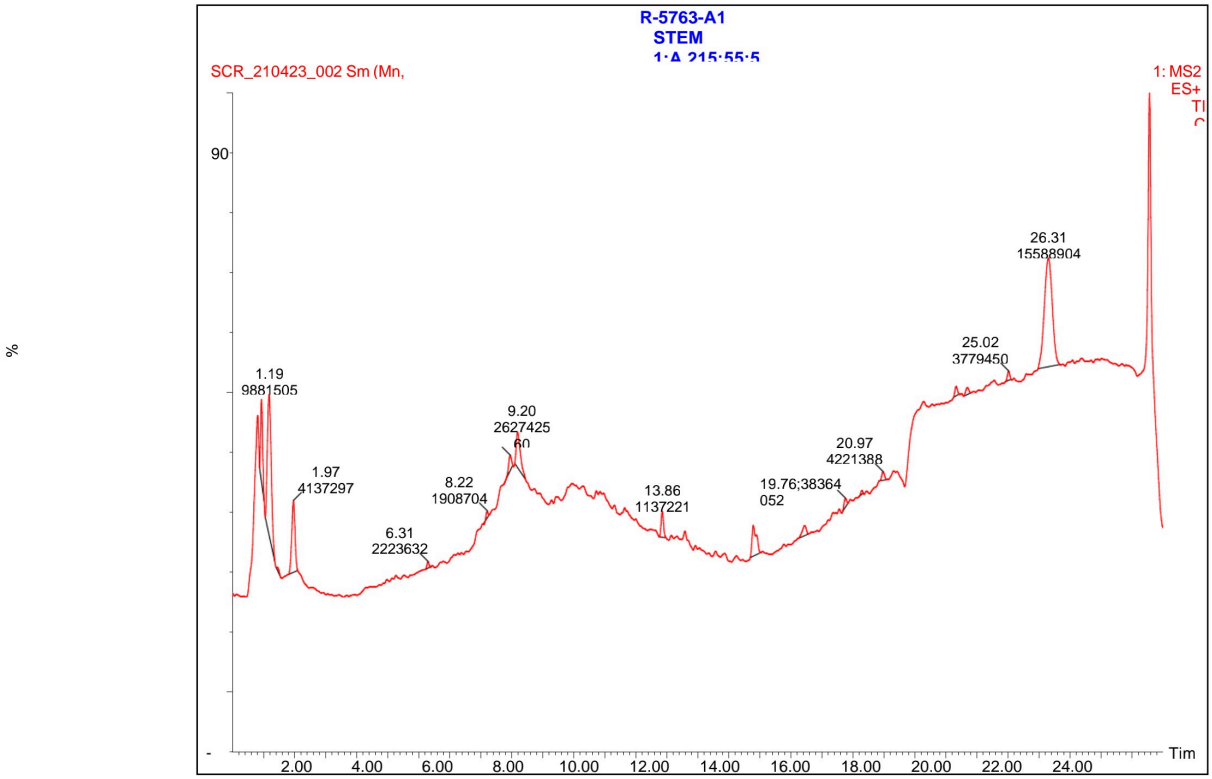


Figure 4: LCMS TIC graph for negative stem extract.

Figure 5: LCMS TIC graph for positive stem extract.



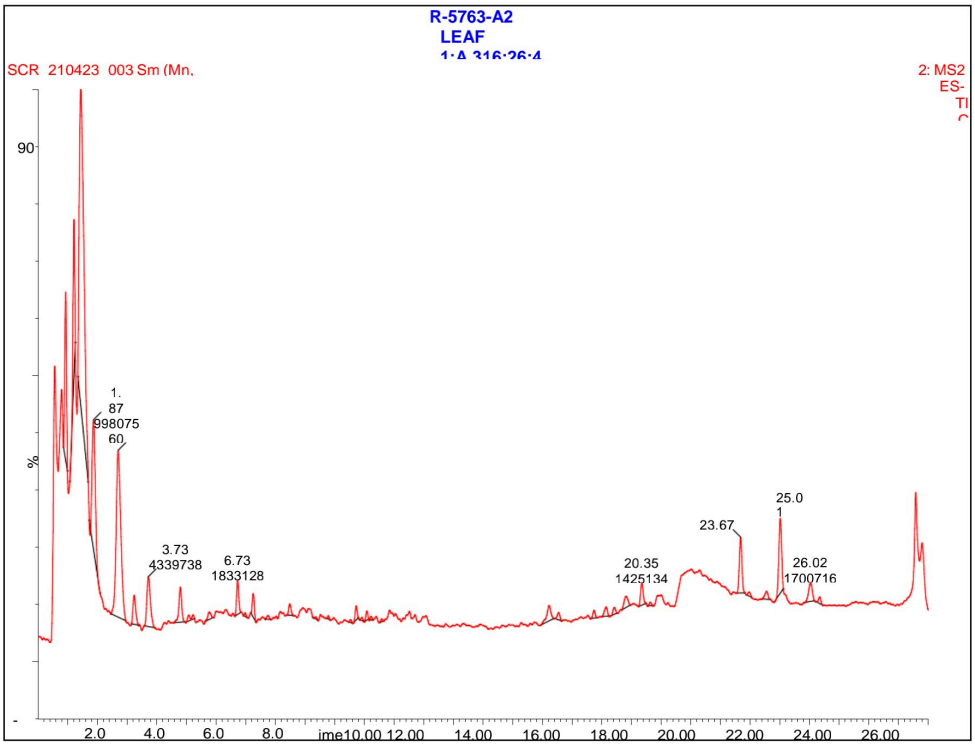


Figure 6: LCMS TIC graph for negative leaf extract.

Figure 7: LCMS TIC graph for positive leaf extract.

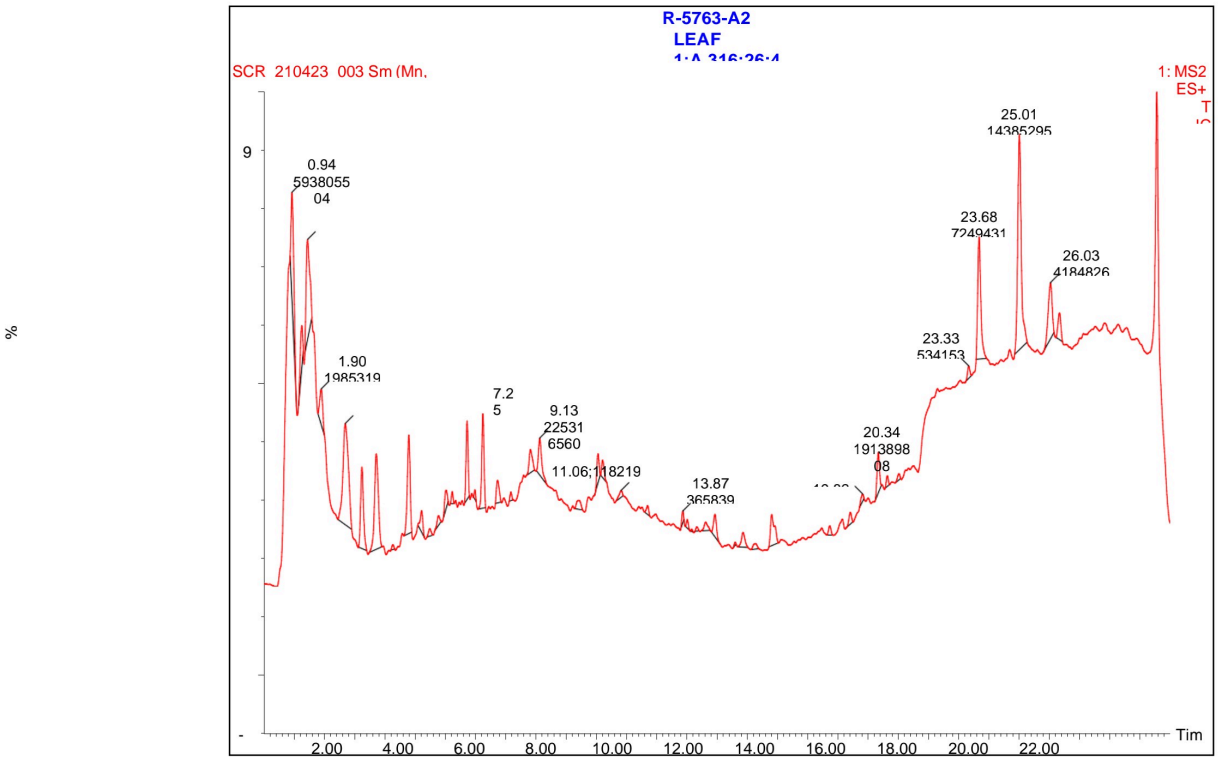


Plate XVII: Dried leaves of *O. tenuiflorum* for GCMS

Plate XVIII: Dried stems of *O. tenuiflorum*

Plate XIX: Dried leaves of *O. tenuiflorum*

Plate XX: Powder of the leaf sample

Plate XXI: Leaf sample powder in methanol

Plate XXII: Stem sample powder in methanol

Plate XXIII: Crude extract of leaves

Plate XIV: crude extract of stems

Plate XV: samples collected

Plate XVI: Extracted samples collected

Figure 8: GCMS tester

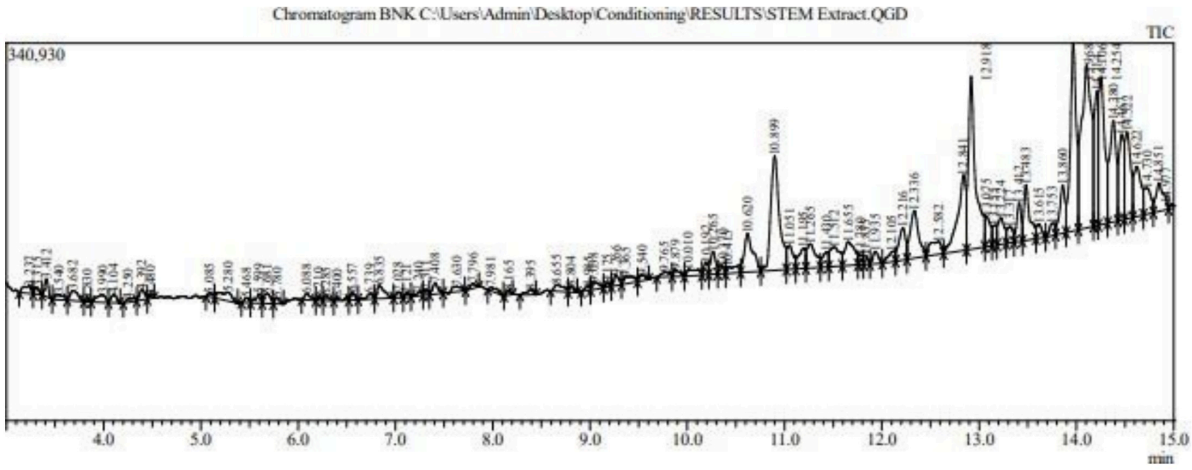


Figure 9: The GCMS condensed graph of phytocompounds of Stem extract

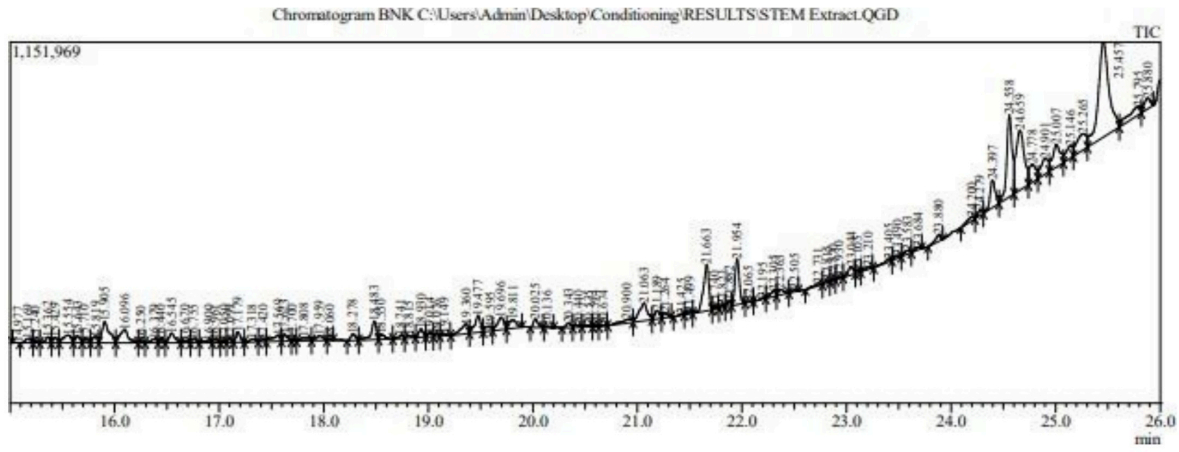


Figure 10: The GCMS condensed graph of phytocompounds of Stem extract

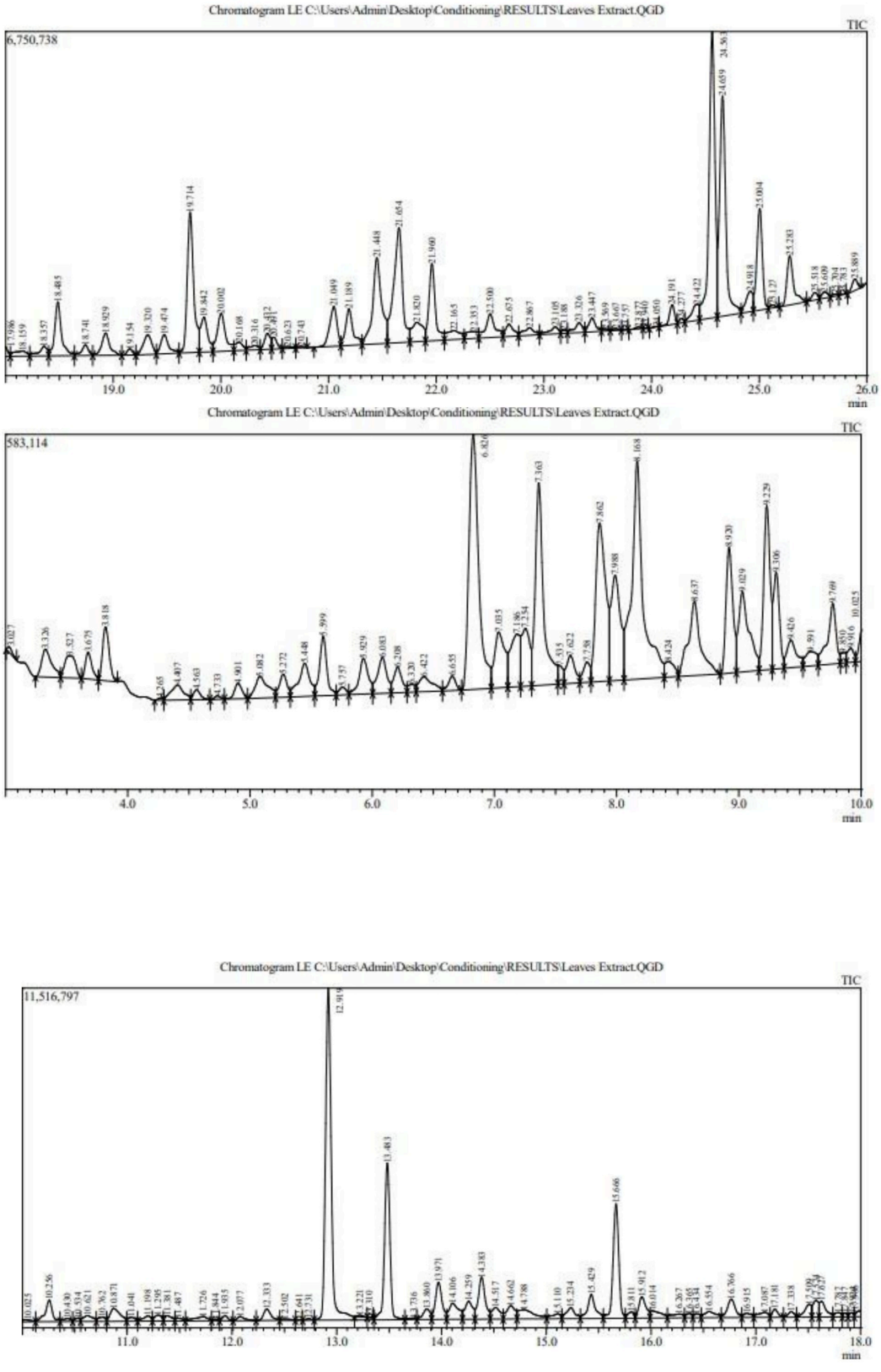


Figure 11: The GCMS condensed graph of phytocompounds of Stem extract

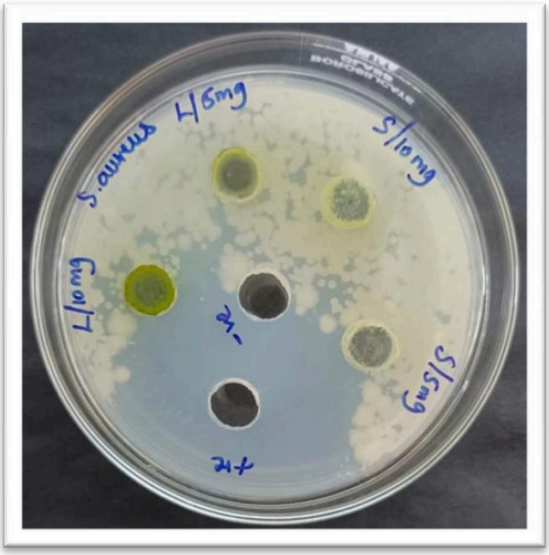


Plate XVII: Anti bacterial test of extract on *S.Aureus*

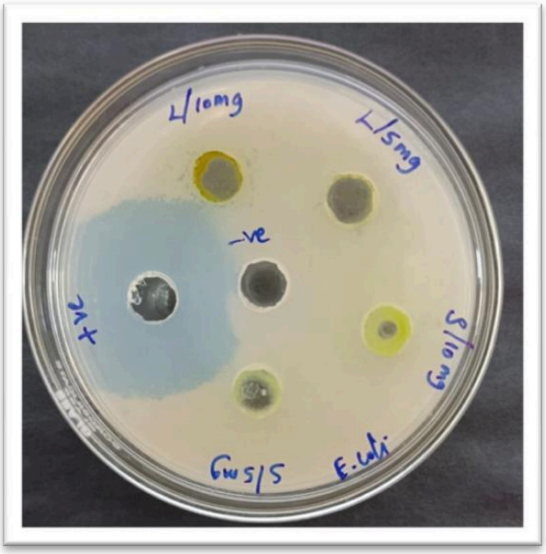


Plate XVIII: Antibacterial test on E.Coli

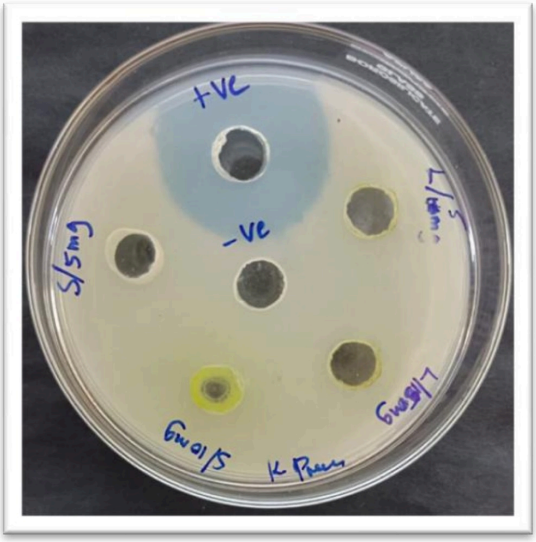


Plate XIX: Antifungal test on *K. Pnemoniae*

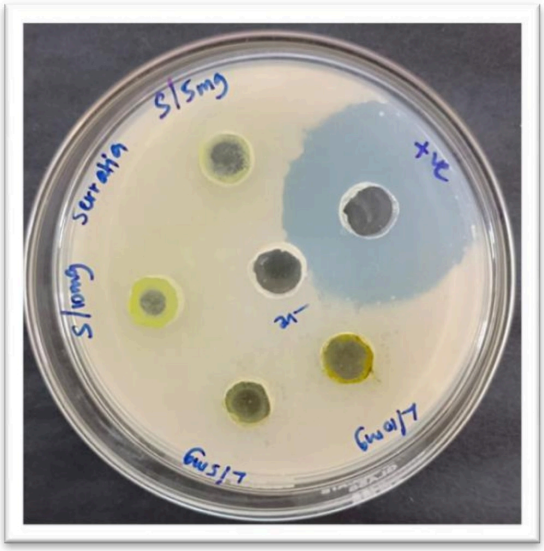


Plate XXX: Antifungal test on *Serratia*

Plate XXXI: Finishing with stem extract

Plate XXXII: Finishing with leaf extract

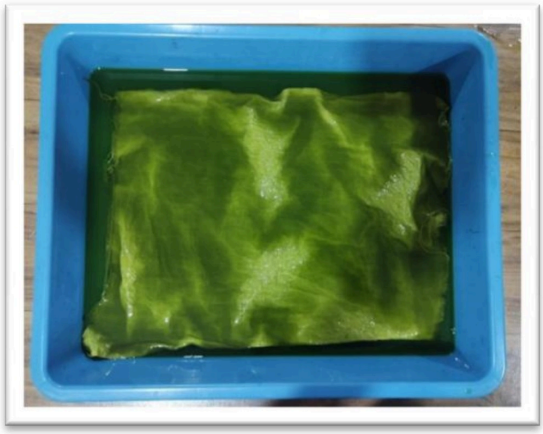


Plate XXXIII: Finishing with stem extract

Plate XXXIV: Finishing with leaf extract

Plate XXXV: Curing and drying of both the samples

Plate XXXVI: Finished samples

Plate XXXVII: Stiffness tester, Thickness tester

Plate XXXVIII: Digital balance

Plate XXXIX: GSM cutter

Plate XXXX: Spray tester

Plate XXXXI: Martindale Abrasion tester

Plate XXXXII: Hot air oven

Plate XXXXIII: Hot air oven

Plate XXXXIV: Stiffness testing

Plate XXXXV: *Escherichia coli*-PL

Plate XXXXVI: *Staphylococcus aureus*-TL

Plate XXXXVII: *Escherichia coli*-PS

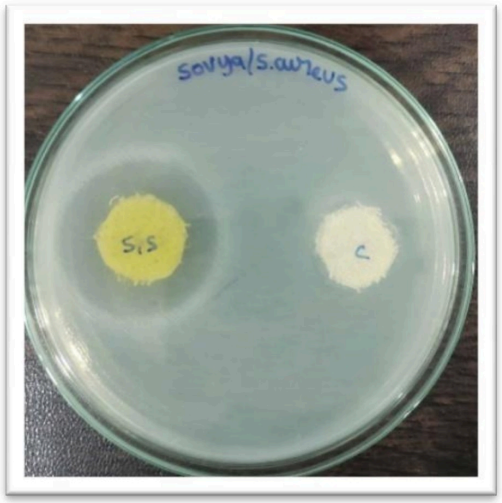


Plate XXXXVIII: *Staphylococcus aureus*-PS

Plate XXXXIX: *Escherichia coli*-TL

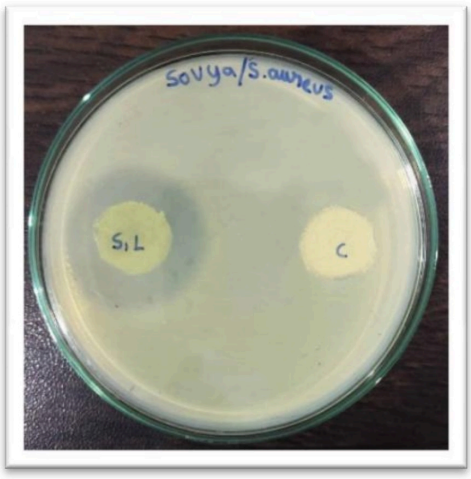


Plate XXXXX: *Staphylococcus aureus*-PL

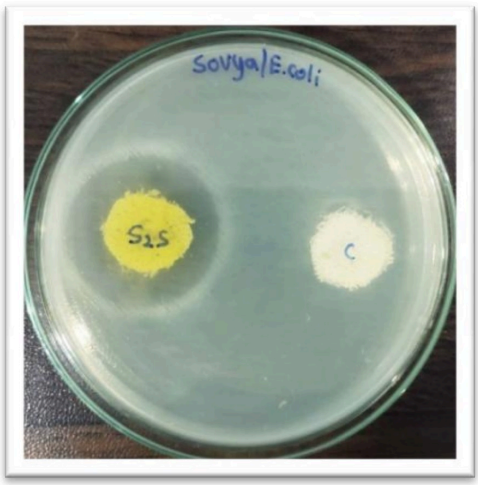


Plate XXXXXI: *Escherichia coli*-TS

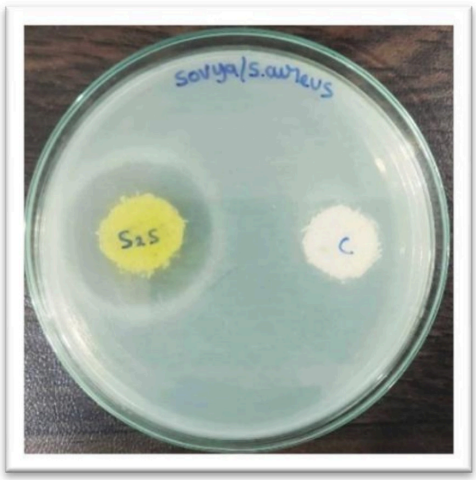


Plate XXXXXII: *Staphylococcus aureus*-TS

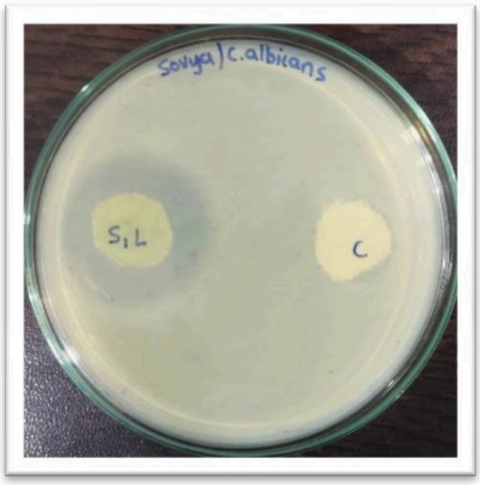


Plate XXXXXIII: *Candida albicans*-PL

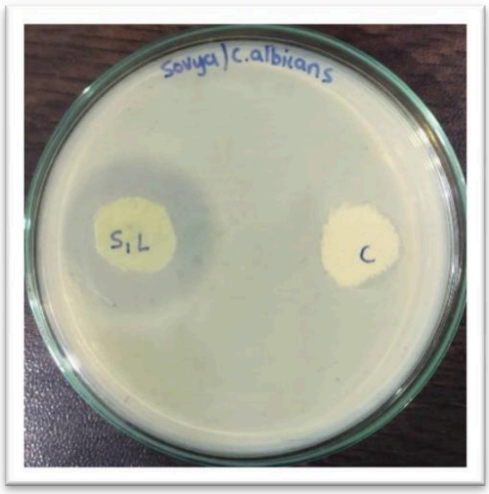


Plate XXXXXIV: *Candida albicans*-TL

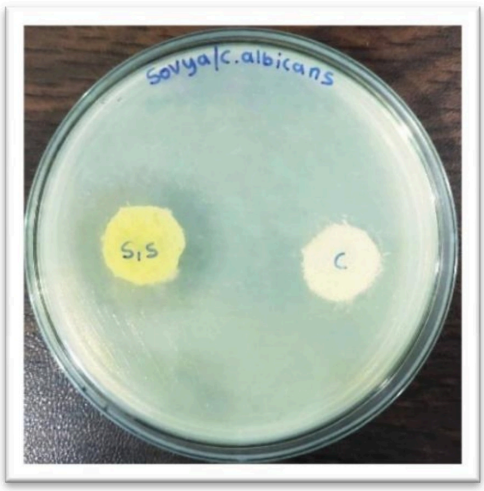


Plate XXXXXV: *Candida albicans*-PS

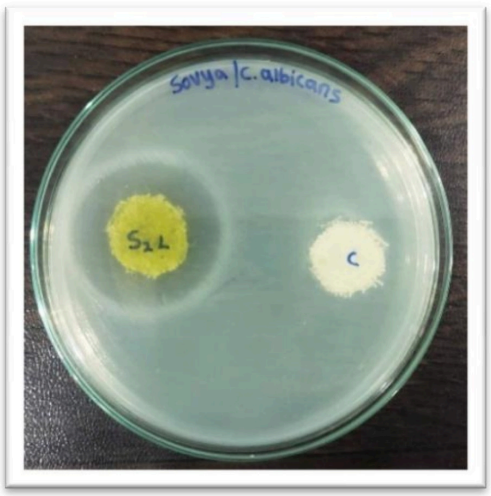


Plate XXXXXVI: *Candida albicans*-TS

Plate XXXXXVII: *Candida tropicalis*-PL

Plate XXXXXVIII: *Candida tropicalis*-TL

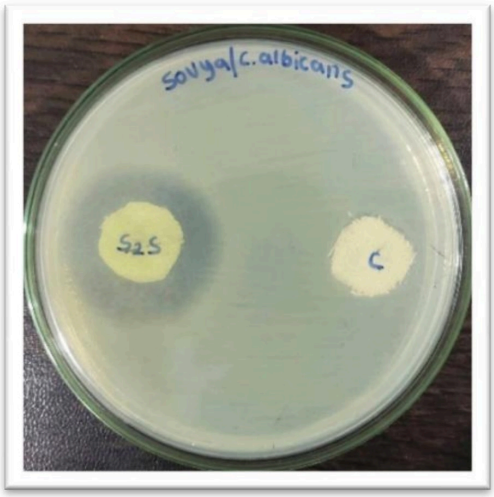


Plate XXXXXIX: *Candida tropicalis*-TS

Plate XXXXXX: *Candida tropicalis*-PS

RESULTS AND DISSCUSSION

4 RESULTS AND DISCUSSION

The results of the study on "**A Comparitive study on Antimicrobial activity of *Ocimum tenuiflorum. Linn* leaves and stem extract on Organic cotton**", is presented in results and discussion is as follows.

4.1 Testing the Extract

4.1.1 Zone of inhibition test

4.1.2 Thin Layer Chromotography

4.2 Subjective evaluation

4.2.1 Visual inspection

4.3 Objective evaluation

4.3.1 Physical and Mechanical evaluation

4.3.1.1 Fabric count

4.3.1.2 Fabric weight

4.3.1.3 Fabric thickness

4.3.1.4 Abrasion resistance

4.3.2 Absorbency evaluation

4.3.2.1 Wicking test

4.3.2.2 Sinking test

4.3.3 Comfort property

4.3.3.1 Fabric stiffness-weft

4.3.3.2 Fabric stiffness-warp

4.3.4 Color fastness test

4.3.4.1 Color fastness to Wet Crocking

4.3.4.2 Color fastness to Dry Crocking

4.3.4.3 Moisture content and regain

4.3.4.4 Spray test

4.3.5 Functional evaluation

4.3.5.1 Anti-bacterial test

4.3.5.2 Anti-fungal test

4.1 Testing the Extract

4.1.1 Zone of inhibition test

Antimicrobial Test on O.tenuiflorum extracts:

Table 1 Zone of Inhibition (mm) by *O.tenuiflorum* methanolic leaves and stem extracts

S.No	Test Pathogens	Zone of Inhibition (mm)					
		L50	L100	S50	S100	+Ve Control	-Ve Control
01	Staphylococcus aureus	10 mm	12 mm	14 mm	16 mm	30 mm	-
02	Streptococcus pneumoniae	8 mm	10 mm	8 mm	10 mm	30 mm	-
03	Enterococus faecalis	-	-	8 mm	10 mm	28 mm	-
04	Escherichia coli	14 mm	16 mm	18 mm	20 mm	29 mm	-
05	Klebsiella pneumoniae	-	-	-	-	26 mm	-
06	Serratia marcescens	-	-	8 mm	10 mm	29 mm	-
07	Salmonella typhi	10 mm	14 mm	14 mm	16 mm	30 mm	-
08	Salmonella paratyphi	12 mm	16 mm	18 mm	22 mm	29 mm	-
09	Candida albicans	10 mm	12 mm	14 mm	16 mm	30 mm	-

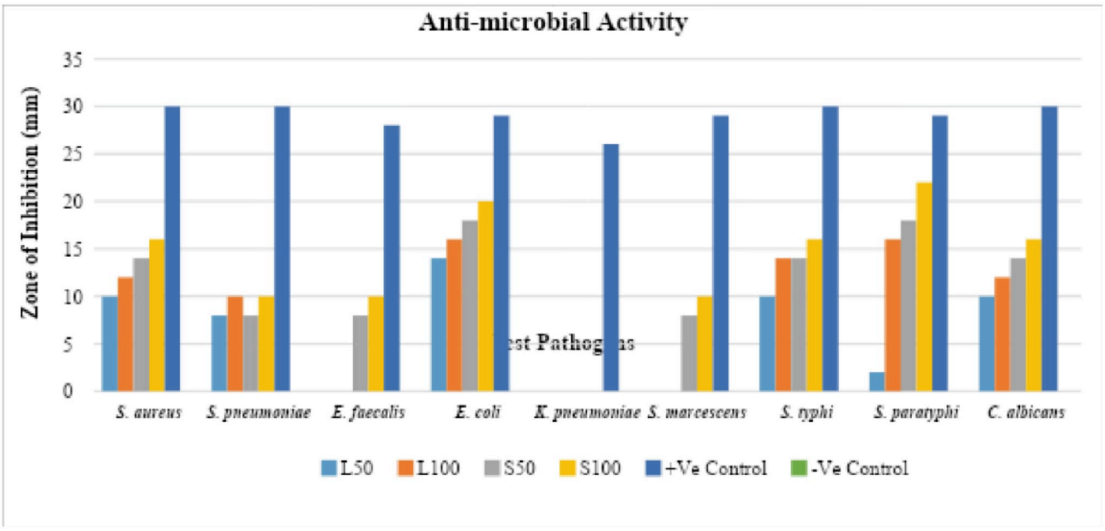


Figure 12: Zone of Inhibition (mm) by Tulsi methanolic leaves and stem extracts

Table No.1 and Figure 12 , compiles zones of inhibition against Staphylococcus aureus, Streptococcus pneumoniae, Enterococus faecalis, Escherichia coli, Klebsiella pneumoniae, Serratia marcescens, Salmonella typhi, and Salmonella paratyphi that were demonstrated by Tulsi leaves and stem extract at two different concentrations (5 mg/mL and 10 mg/mL).

Antibacterial activity results revealed the test sample S100 (Stem extract - 10 mg/mL) showed the maximum zone of inhibition against Salmonella paratyphi (22 mm) followed by Escherichiacoli (20 mm). The sample S50 (Stem extract - 5 mg/mL) showed the maximum zone of inhibition against Salmonella paratyphi (18 mm) and Escherichia coli (20 mm). The sample S50 (Stem extract - 5 mg/mL) and S100 (Stem extract - 10 mg/mL) showed better anti-bacterial activity against clinical bacterial pathogens. Likewise, the test sample L50 (Leaves extract - 5 mg/mL) and L100 (Leaves extract - 10 mg/mL) showed maximum zone of inhibition against Escherichia coli (14 mm and 16 mm) respectively. Similarly, the L100 showed better anti-bacterial activityagainst Salmonella typhi (12 mm), Salmonella paratyphi (16 mm).

A number of other studies support the hypothesis that Tulsi have antimicrobial, antioxidant, antifungal, and anti-inflammatory properties, which may explain its effectiveness against the microorganisms previously mentioned (Nahak et al., 2011; Singhal, et al., 2011; Okigbo, R.N., and Mmeka, E. C. 2006). The present study is one of the first to evaluate the methanolic extract of Tulsi leaves and stems' antimicrobial activity against fungi and bacteria. Due to variation in the organisms tested against Tulsi for its antimicrobial effect, comparisons with previous studies are not justified in this case.

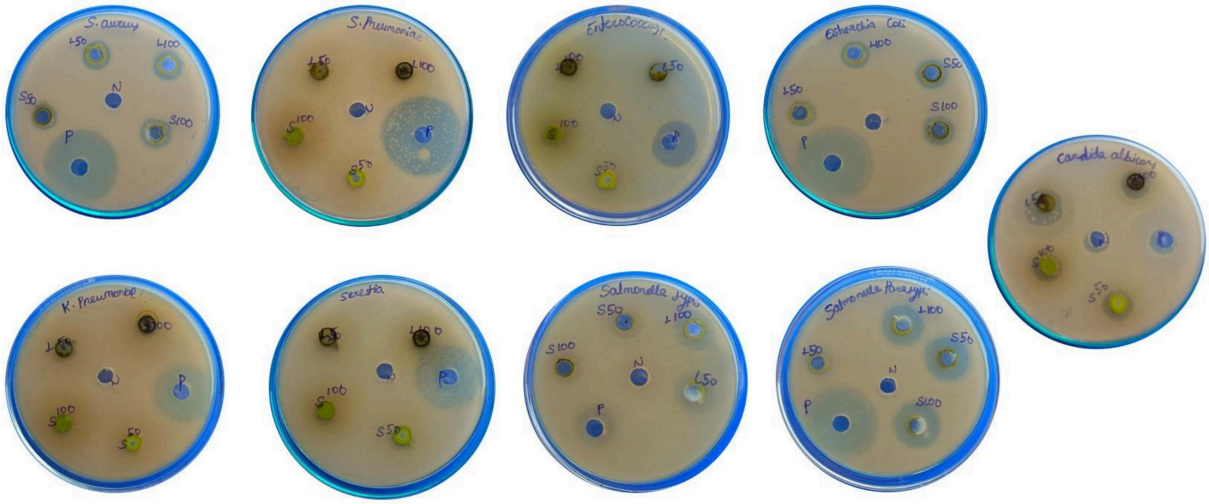


Figure13: - Antimicrobial activity of methanolic tulsi leaves and stem extracts

4.1.2 Thin Layer Chromatography

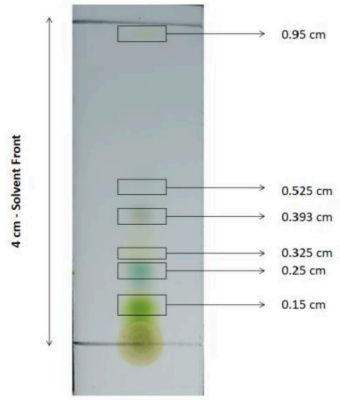
The analytical TLC method was used to count the number of phytocompounds in the methanolic crude extracts. The chromatographic spots which were illustrative of mixtures in the different concentrates were noticed, and their Rf was calculated. The results of the TLC analysis are presented in Table . Six distinct spots with Rf values such as 0.15 cm, 0.25 cm, 0.325 cm, 0.3925 cm, 0.525 cm, and 0.95 cm were observed in the methanolic extracts of tulsi leaves was shown in Figure . Similarly, three distinct spots with Rf values such as 0.143 cm, 0.228 cm, and 0.314 cm was shown in Figure .

When compared to the phytochemicals that were found to be present in leaves extract at the given mobile phase, the number of spots indicating the separated components stem extracts of tulsi was less. Due to the use of a less polar solvent system as the mobile phase, this indicates that some of the components co eluted in mixtures or did not elute on the TLC plate. To completely separate the components, two-dimensional TLC, column chromatography, or high-pressure liquid chromatography (HPLC) may be required.

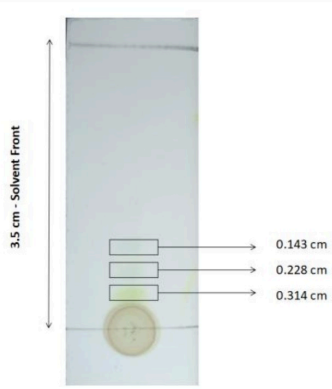
Table No.2: Phytocompounds in tulsi methanolic extracts retention factor (Rf) determined using TLC

Phytocompounds	Retention Factor (Rf) in cm	
	Tulsi leaf extract	Tulsi stem extract
Compound A	0.15	0.143
Compound B	0.25	0.228
Compound C	0.325	0.314
Compound D	0.393	-
Compound E	0.525	-
Compound F	0.95	-

Figure 14:



Thin Layer Chromatogram of Methanolic Tulsi Leaves Extract



Thin Layer Chromatogram of Methanolic Tulsi Stem Extract

4.2 Subjective evaluation

4.2.1 Visual inspection

The 30 post graduate students from textiles and clothing department were selected for evaluating the finished fabric of both leaves and stem extract which were woven on plainand twill weave as given in table 3

S.no	Finished Samples	Rating in percentage							
		Texture			Appearance			Evenness in finishing	
		Good	Fair	Poor	Good	Fair	Poor	Even	Uneven
01	Leaf extract - Plain weave	90	10	00	96	04	00	98	02
02	Leaf extract - Twill weave	98	02	00	97	03	00	100	00
03	Stem extract - Plain weave	92	05	03	95	04	01	99	01
04	Stem extract - Twill weave	94	05	01	93	07	00	99	01

According to Table 3, the overall look of the finished organic cotton fabric was assessed as satisfactory, as indicated by 96%., 97%, 95%, and 93% for PL, TL, PS, and TS respectively. Because of the fabric look and evenness in finishing, the evenness and texture of finished cotton fabric are assessed as 98%, 100%, 99%, 99% and 90%, 98%, 92%, 94% for PL, TL, PS, and TS respectively. So the final conclusion is that TL sample has a good appearance, texture, and evenness in finishing.

PL - Plain weave Leaf extract

TL-Twill weaves Leaf extract

PS - Plain weave Stem extracts

TS - Twill weaves Stem extract

4.3 Objective evaluation

4.3.1 Physical and Mechanical evaluation

4.2.1.1 Fabric count - Table 4: Anova for Fabric Count (EPI)

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	62	1.414	4.10	0.006*
02	Grey fabric - Twill weave	69	5.66		
03	Leaf extract - Plain weave	63	4.24		
04	Stem extract - Plain weave	64	5.66		
05	Leaf extract - Twill weave	70	1.414		
06	Stem extract - Twill weave	71	7.07		

*-Significant at 5% level

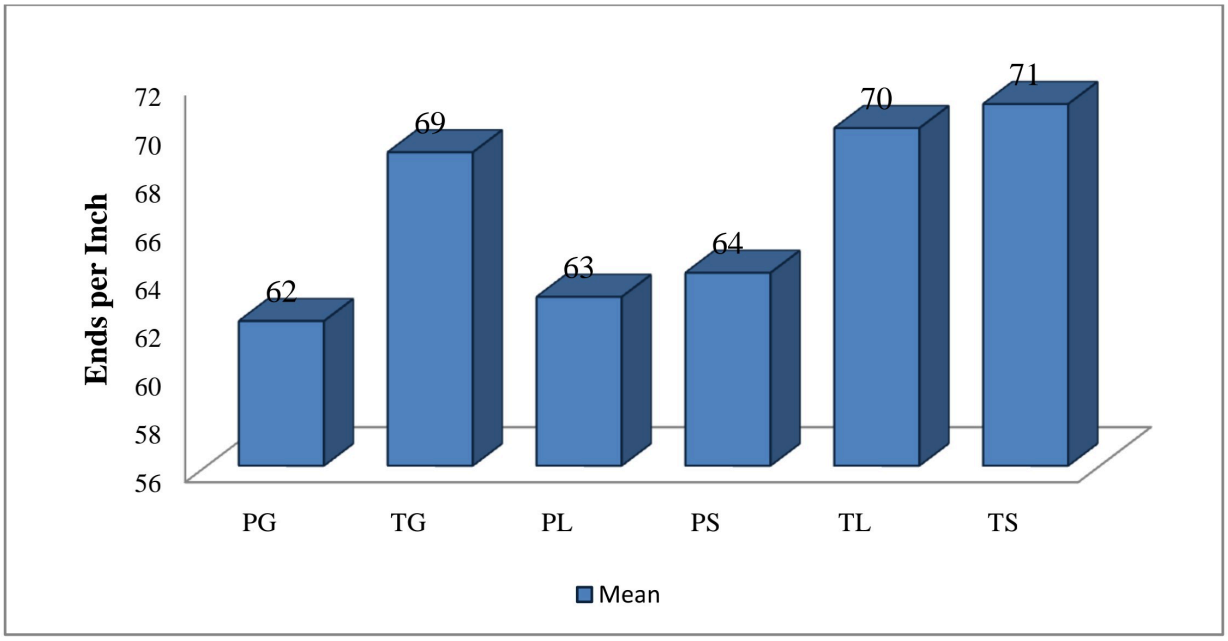


Figure – 14

Fabric Count (EPI)

As per the table 4, it is clear that the Mean value of end per inch Sample of PG, TG, PL, PS, TL, and TS are 62, 69, 63, 64, 70, and 71 respectively. There is an increase in the EPI value of finished fabrics compared to the grey fabric because of desizing them and treating them with an antimicrobial finish. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 4.10.

4.2.1.1 Fabric count - Table 5: Anova for Fabric count (PPI)

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	62	1.414	3.84	0.008*
02	Grey fabric - Twill weave	72	5.66		
03	Leaf extract - Plain weave	63	4.24		
04	Stem extract - Plain weave	65	7.07		
05	Leaf extract - Twill weave	72	2.83		
06	Stem extract - Twill weave	73	11.31		

*-Significant at 5% level

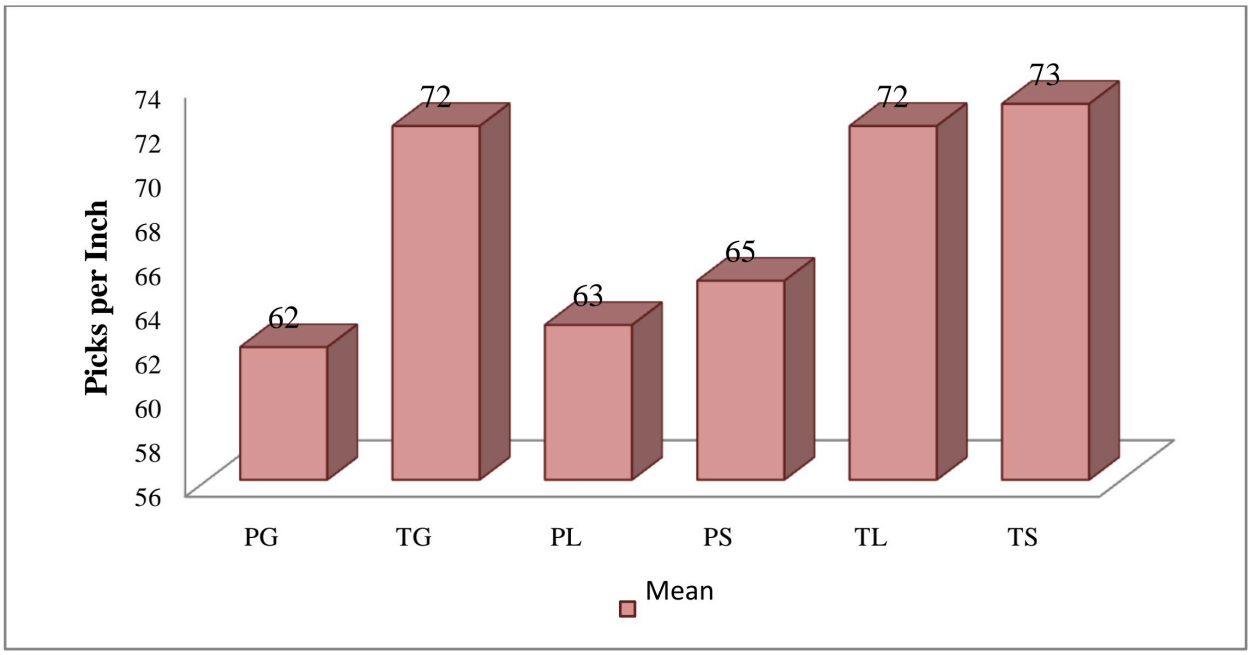


Figure – 15

Fabric Count (PPI)

As per the table 5, the Mean value of picks per inch Sample of PG, TG, PL, PS, TL, and TS are62, 72, 63, 65, 72, and 73 respectively. There is an increase in the PPI value of finished fabrics compared to the grey fabric because of desizing them and treating them with an antimicrobial finish. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 3.84.

4.2.1.2 Fabric weight - Table 6: Anova for Fabric weight

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	168.2	14.14	4.97	0.002*
02	Grey fabric - Twill weave	180.2	2.83		
03	Leaf extract - Plain weave	166.2	8.49		
04	Stem extract - Plain weave	170	7.07		
05	Leaf extract - Twill weave	181.2	1.414		
06	Stem extract - Twill weave	181.2	5.66		

*-Significant at 5% level

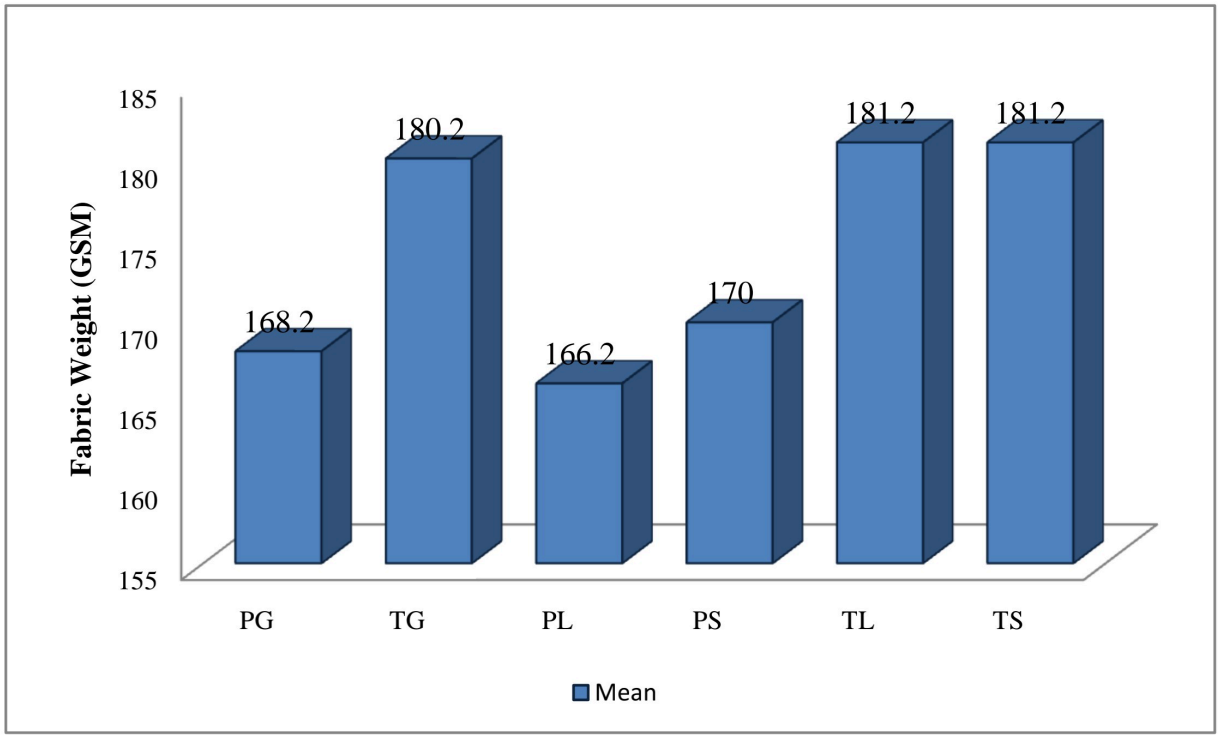


Figure – 16

Fabric weight (GSM)

As per the table 6, the Mean value of fabric weight of the Sample of PG, TG, PL, PS, TL, and TS are 168.2, 180.2, 166.2, 170, 181.2, and 181.2 respectively. There is a decrease in the fabric weight of PL compared to PG and an increase in PS mean value when also compared to PG; the fabric weight of both TL and TS have an increase compared to TG of finished fabrics due to the desizing method and treatment with antimicrobial finish using the extracts of *O.tenuiflorum*. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 4.97.

4.2.1.3 Fabric thickness - Table 7: Anova for Fabric Thickness Test

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	1.84	0.1414	3.17	0.20*
02	Grey fabric - Twill weave	2.234	0.1414		
03	Leaf extract - Plain weave	1.848	0.1667		
04	Stem extract - Plain weave	1.842	0.0682		
05	Leaf extract - Twill weave	2.228	0.374		
06	Stem extract - Twill weave	2.232	0.566		

*-Significant at 5% level

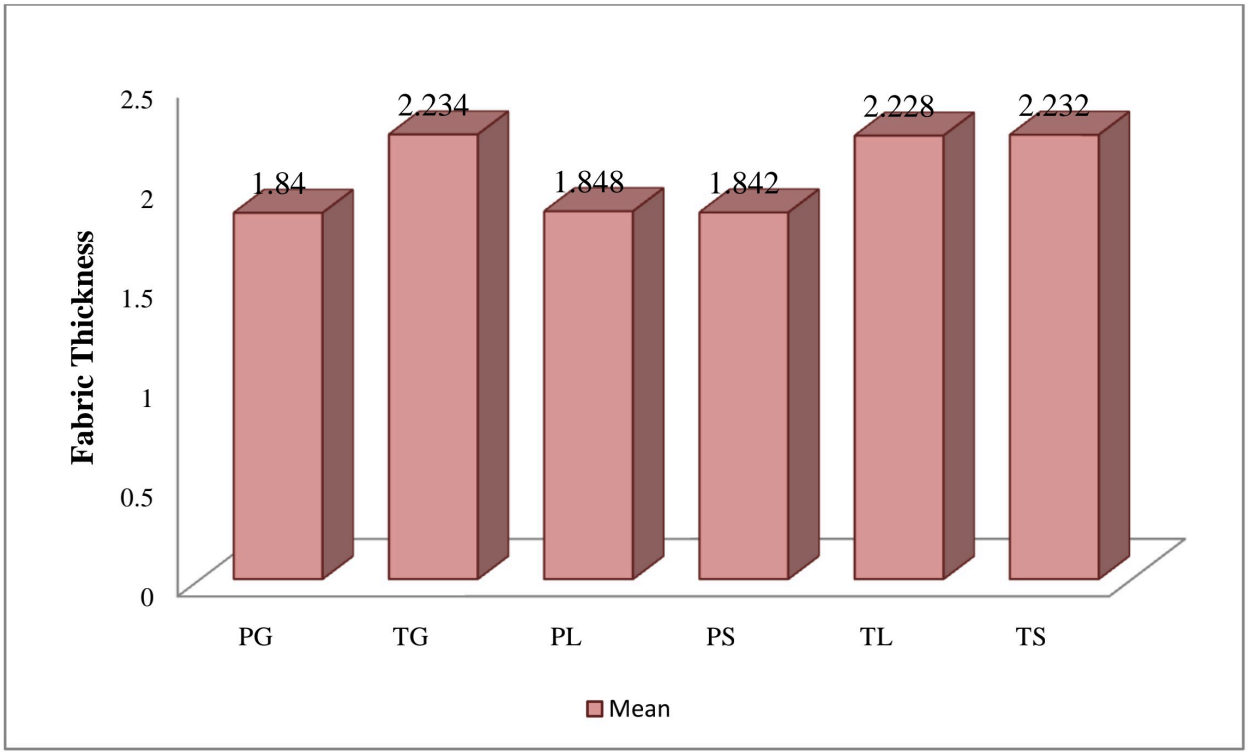


Figure – 17

Fabric thickness

As per the table 7, the Mean value of fabric thickness of the Sample of PG, TG, PL, PS, TL, and TS are 1.84, 2.23, 1.85, 1.84, 2.23, and 2.23 respectively. There is an increase in the thickness value of finished fabrics compared to the grey fabric because of desizing them and treating them with an antimicrobial finish. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 3.17.

4.2.1.4 Abrasion resistance - Table 8: Anova for Fabric Abrasion Test

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	0.016	0.001	3.05	0.024*
02	Grey fabric - Twill weave	0.016	0.002		
03	Leaf extract - Plain weave	0.022	0.004		
04	Stem extract - Plain weave	0.02	0.007		
05	Leaf extract - Twill weave	0.022	0.001		
06	Stem extract - Twill weave	0.02	0.002		

*-Significant at 5% level

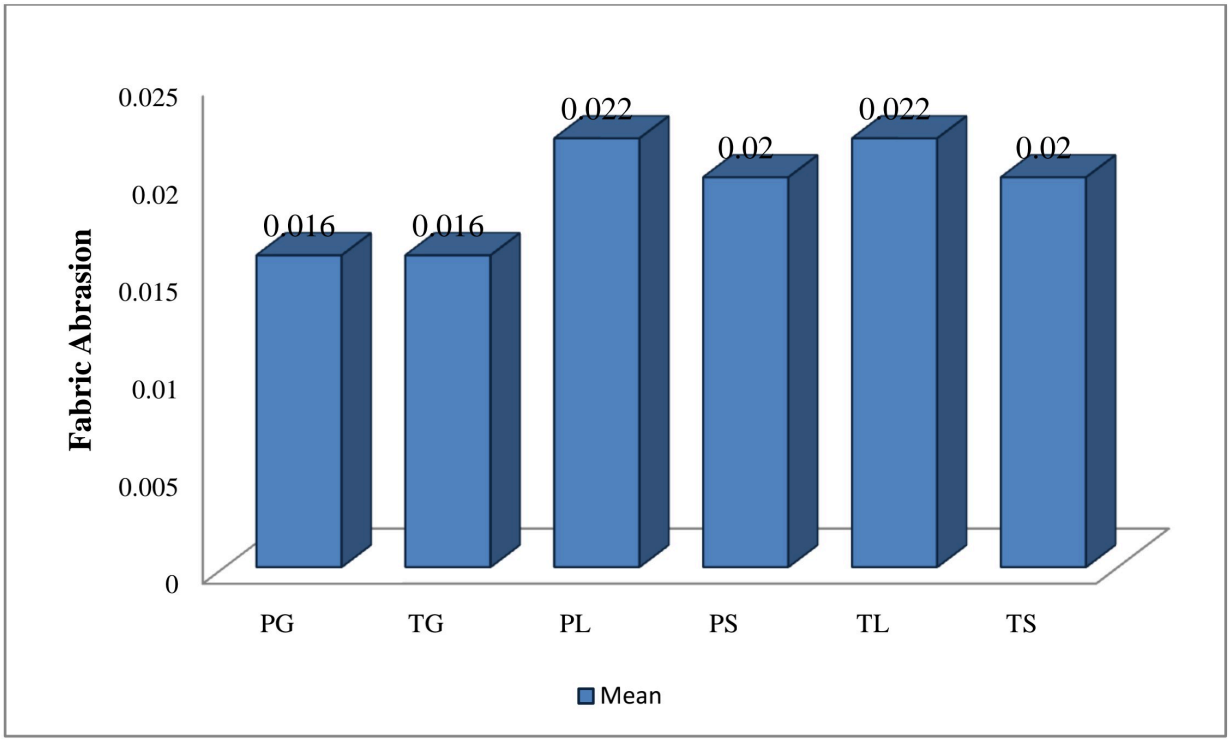


Figure – 18

Fabric Abrasion

As per the table 8, the Mean value of fabric abrasion of the Sample of PG, TG, PL, PS, TL, and TS are 0.016, 0.016, 0.022, 0.02, 0.022, and 0.02 respectively. There is no big difference in the value of weight loss of finished fabrics compared to the grey fabric because of the yarn spun method, weave structure, and treating them with an antimicrobial finish. There is a great significant difference that says that the fabric has a very good resistance to abrasion. Statistical analysis also proves a significant difference at a 5% level between the samples withan F value of 3.05.

4.2.2 Absorbency evaluation

4.2.2.1 Wicking test – Table 9: Anova for Fabric Wicking Test

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	2.26	0.707	4.54	0.003*
02	Grey fabric - Twill weave	2.16	0.226		
03	Leaf extract - Plain weave	1.76	0.283		
04	Stem extract - Plain weave	1.02	0.028		
05	Leaf extract - Twill weave	1.92	0.424		
06	Stem extract - Twill weave	1.88	0.849		

*-Significant at 5% level

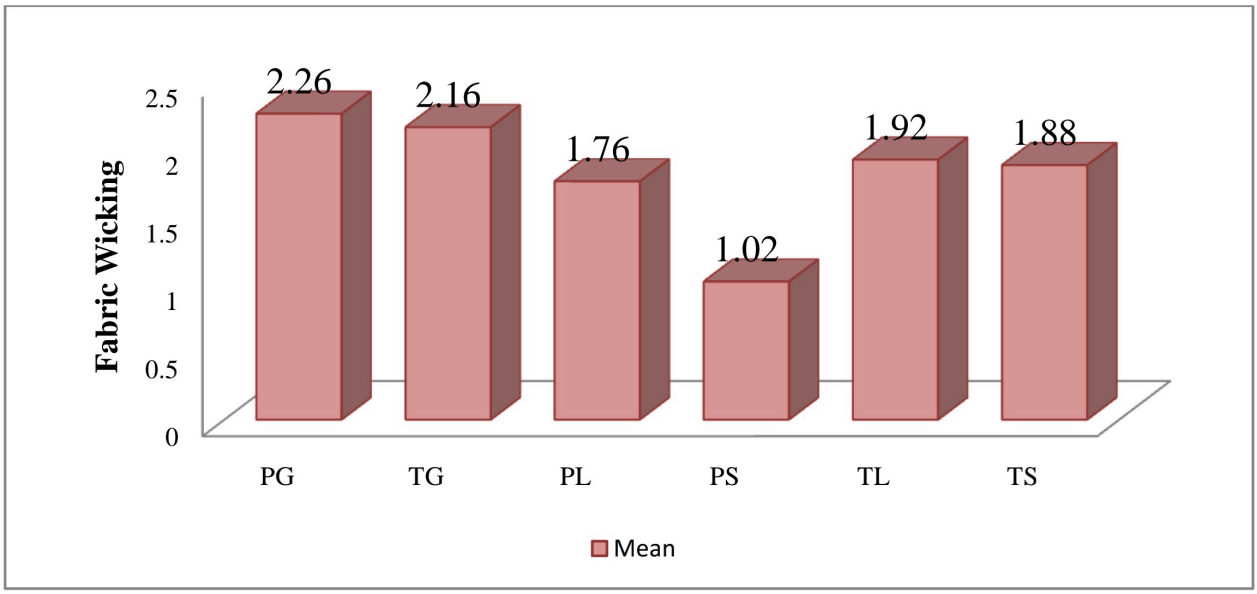


Figure – 19

Fabric wicking

As per the table, the Mean time of fabric wicking of the Sample of PG, TG, PL, PS, TL, and TS are 2.26, 2.16, 1.76, 1.02, 1.92, and 1.88 respectively. There is a decrease in the wicking time value of finished fabrics compared to the grey fabric because of treating them with an antimicrobial finish using the extract. PS sample has the least wicking property and PG sample has the highest wicking property. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 4.54.

4.2.2.2 Sinking test - Table 10: Anova for Fabric Sinking Test

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	12.6	1.141	105.06	0.001*
02	Grey fabric - Twill weave	15.6	0.707		
03	Leaf extract - Plain weave	41.8	14.14		
04	Stem extract - Plain weave	106.6	7.07		
05	Leaf extract - Twill weave	72.8	72.8		
06	Stem extract - Twill weave	79.4	12.73		

*-Significant at 5% level

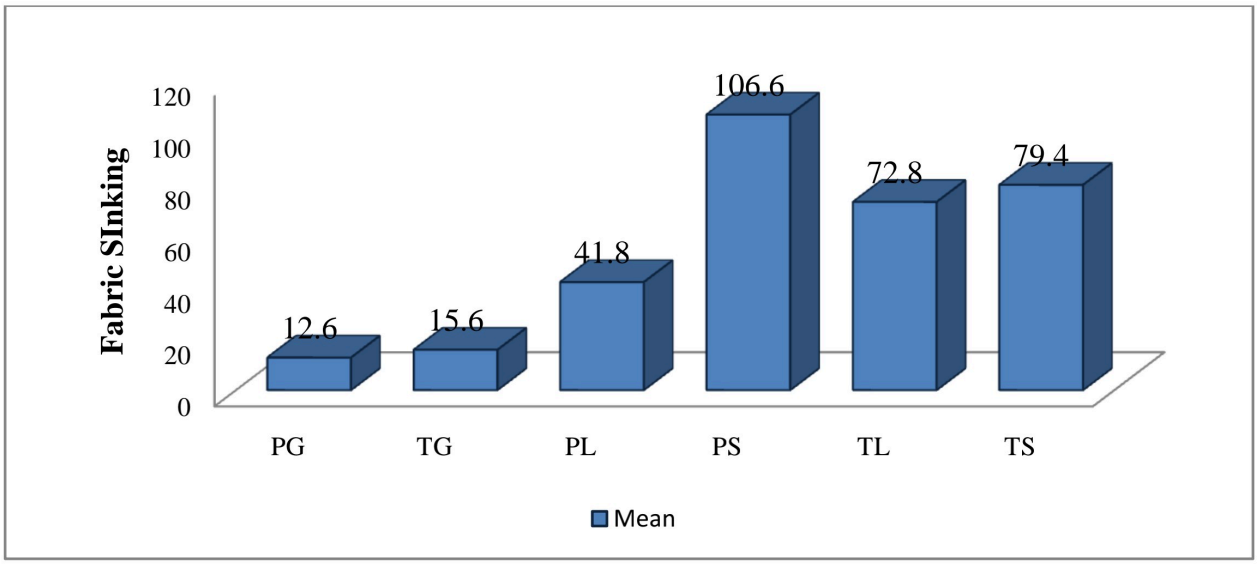


Figure – 20

Fabric sinking

As per the table10, the Mean value of fabric sinking of the Sample of PG, TG, PL, PS, TL, and TS are 12.6, 15.6, 41.8, 106.6, 72.8, and 79.4 respectively. There is an increase in the sinking time of finished fabrics compared to the grey fabric because of treatment with the antimicrobial finish, as it is making the fabric more repellent to liquid. PS sample takes more time to sink and PG takes the least time to sink, making clear that PG has a good sinking property. Statistical analysis also proves a significant difference at a 5% level between the samples withan F value of 105.06.

4.2.3 Comfort property

4.2.3.1 Fabric stiffness-weft - Table 11: Anova for Fabric Stiffness - Weft

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	1.64	0.141	4.37	0.004*
02	Grey fabric - Twill weave	1.64	0.283		
03	Leaf extract - Plain weave	1.7	0.045		
04	Stem extract - Plain weave	1.78	0.07		
05	Leaf extract - Twill weave	1.42	0.056		
06	Stem extract - Twill weave	1.64	0.084		

*-Significant at 5% level

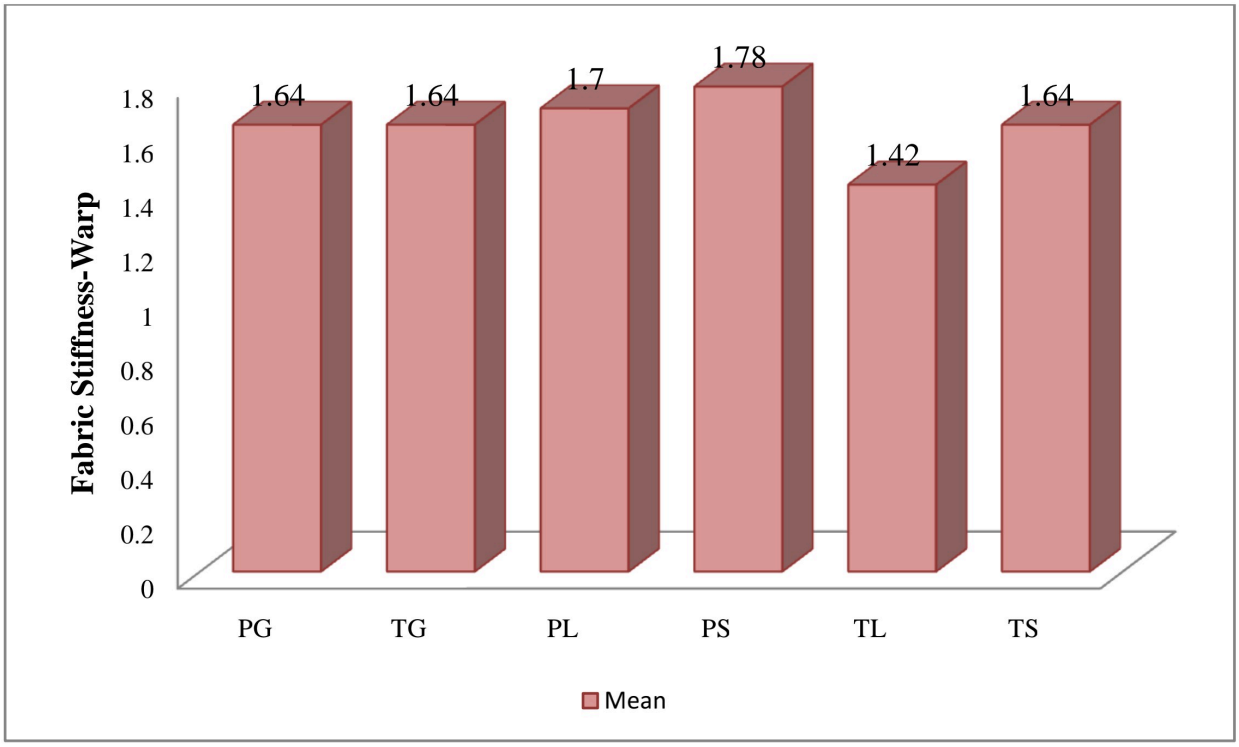


Figure - 21

Fabric Stiffness - Weft

As per the table 11, the Mean value of Fabric stiffness in weft direction of the Sample of PG, TG, PL, PS, TL, and TS are 1.64, 1.64, 1.7, 1.78, 1.42, and 1.64 respectively. There is an decrease in the bending value of TL and TS compared to TG and increase in PL and PS as compared to PG because of desizing them and treating them to give an antimicrobial finish. So treated sample PL and PS are little more rigid than treated sample TL and TS compared to the grey fabrics. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 4.37.

4.2.3.2 Fabric stiffness-warp - Table 12: Anova for Fabric Stiffness - Warp

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	2.64	0.198	3.35	0.016*
02	Grey fabric - Twill weave	2.68	0.424		
03	Leaf extract - Plain weave	3.01	0.1414		
04	Stem extract - Plain weave	2.86	0.283		
05	Leaf extract - Twill weave	2.48	0.283		
06	Stem extract - Twill weave	2.52	0.2121		

*-Significant at 5% level

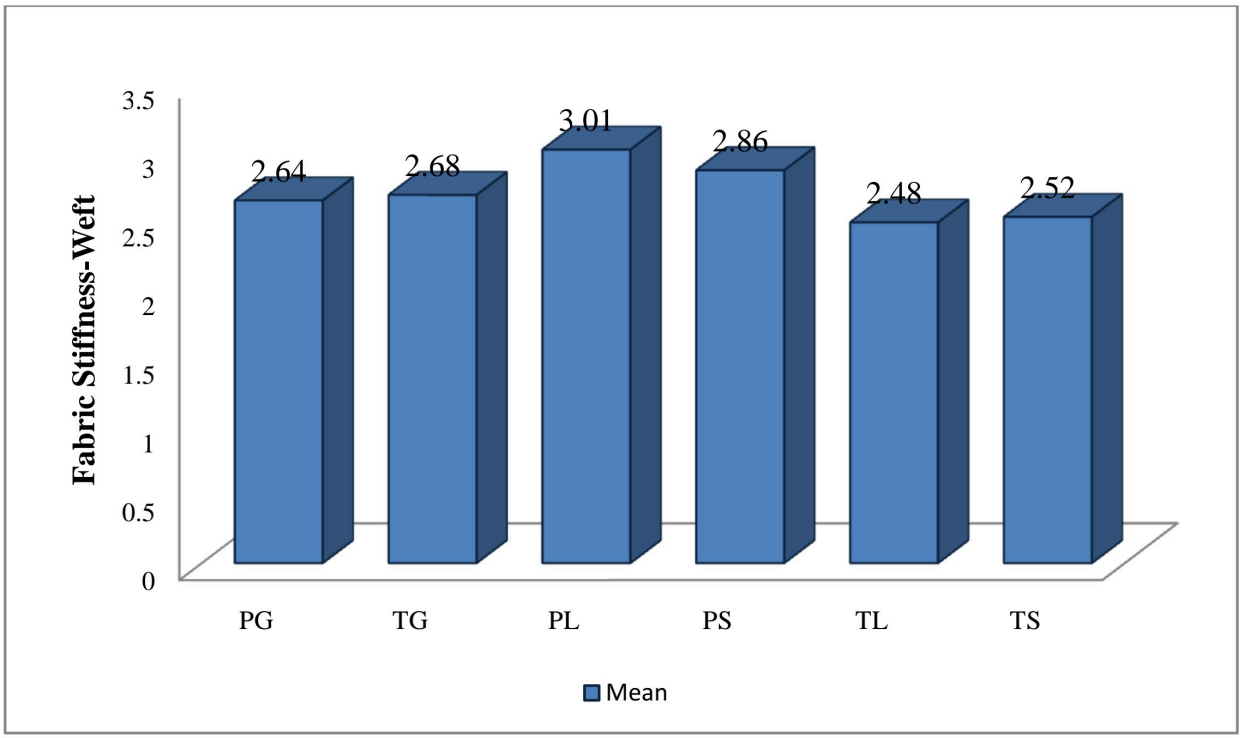


Figure - 22

Fabric Stiffness - Warp

As per the table 12, the Mean value of Fabric stiffness in warp direction of the Sample ofPG, TG, PL, PS, TL, and TS are 2.64, 2.68, 3.01, 2.86, 2.48, and 2.52 respectively. There isan decrease in the bending value of TL and TS compared to TG and increase in PLand PS as compared to PG because of to the deposition of dye particle increases; the fabric stiffness increases. So treated sample PL and PS are a little more rigid than treated sample TL and TS compared to the grey fabrics. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 3.35.

4.2.4 Color fastness test

4.2.4.1 Color fastness to Crocking (wet and dry) - Table 13: Anova for Fabric wet Crocking Test

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	2	0.707	3.96	0.007*
02	Grey fabric - Twill weave	2.2	0.99		
03	Leaf extract - Plain weave	3.4	0.566		
04	Stem extract - Plain weave	2.4	0.031		
05	Leaf extract - Twill weave	3.6	1.414		
06	Stem extract - Twill weave	2.6	0.283		

*-Significant at 5% level

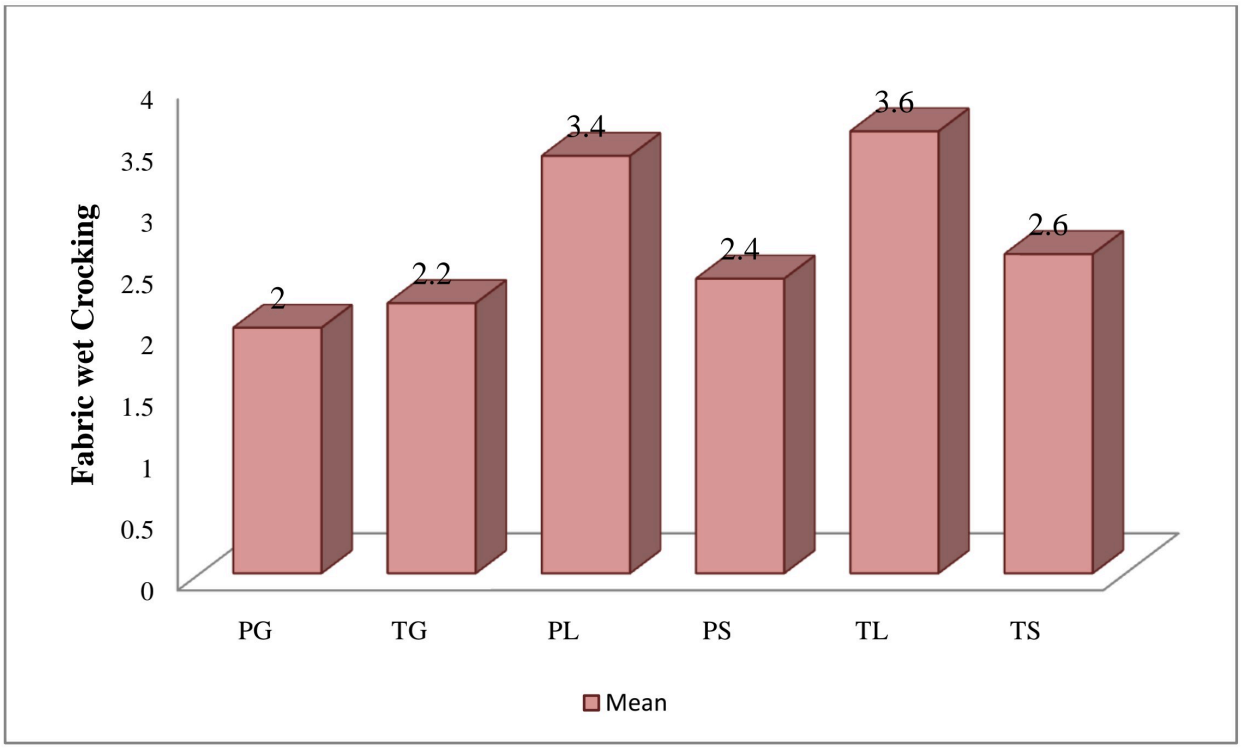


Figure – 23

Fabric wet Crocking

As per the table 13, the Mean value of fabric wet crocking of the Sample of PG, TG, PL, PS,TL, and TS are 2, 2.2, 3.4, 2.4, 3.6, and 2.6 respectively. There is a difference in finished fabrics compared to the grey fabric because of desizing them and treating them to an antimicrobial finish. There is no staining and color change in the finished fabrics PL, PS, TL, and TS. Statistical analysis also proves a significant difference at a 5% level between the sampleswith an F value of 3.96.

4.2.4.1 Color fastness to Crocking (wet and dry) - Table 14: Anova for Fabric dry Crocking Test

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	1.2	0.707	5.48	0.001*
02	Grey fabric - Twill weave	1.4	0.849		
03	Leaf extract - Plain weave	2.6	2.6		
04	Stem extract - Plain weave	1.8	0.849		
05	Leaf extract - Twill weave	4	1.722		
06	Stem extract - Twill weave	2.2	1.414		

*-Significant at 5% level

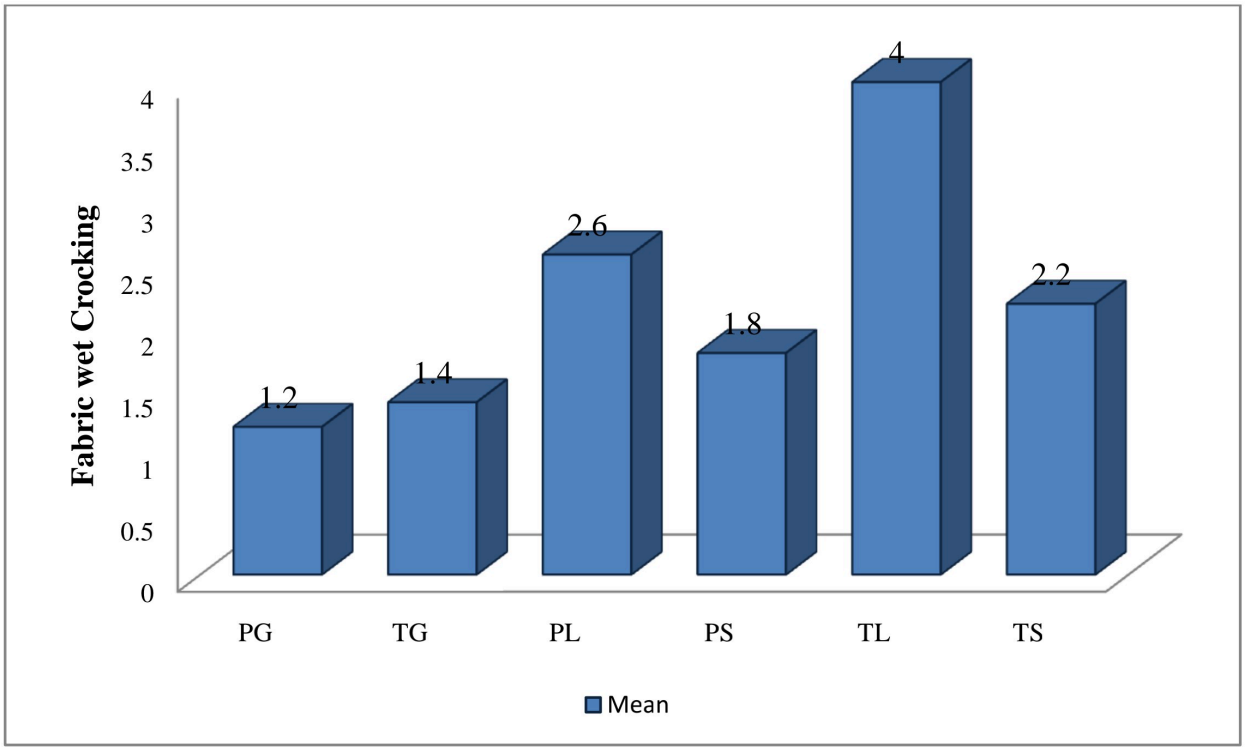


Figure – 24

Fabric dry Crocking

As per the table 14, the Mean value of picks per inch Sample of PG, TG, PL, PS, TL, and TS are 1.2, 1.4, 2.6, 1.8, 4, and 2.2 respectively. There is a difference in finished fabrics compared to the grey fabric because of desizing them and treating them to an antimicrobial finish. Thereis a little color staining in TL in dry state. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 5.48.

4.2.4.2 Moisture content and regain - Table 15: Anova for Fabric Moisture content

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	8.5	8.5	5.66	0.001*
02	Grey fabric - Twill weave	6.6	2.26		
03	Leaf extract - Plain weave	8.4	8.57		
04	Stem extract - Plain weave	7.2	7.2		
05	Leaf extract - Twill weave	8.87	1.55		
06	Stem extract - Twill weave	1.13	1.13		

*-Significant at 5% level

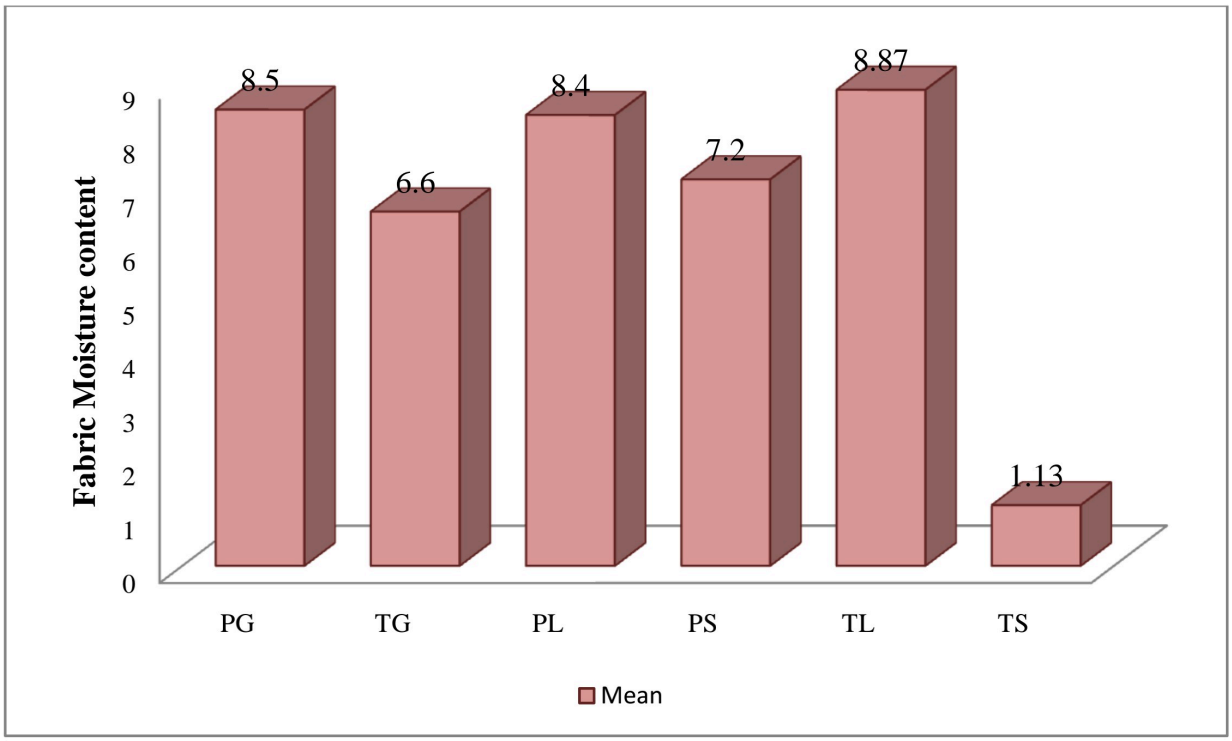


Figure - 25

Fabric Moisture content

As per the table 15, the Mean value of picks per inch Sample of PG, TG, PL, PS, TL, and TS are 8.5, 6.6, 8.4, 7.2, 8.87, and 1.13 respectively. There is an increase in the moisture contentvalue of TL compared to TG because of the deposition of extract components onto the fabric and the twill weave being courser than plain weave and rest all other finished fabrics compared to the grey fabric have decreased because of desizing them and treating them to givean antimicrobial finish. TS have the least moisture content. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 5.66.

4.2.4.2 Moisture content and regain - Table 16: Anova for Fabric Moisture Regain

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	8.3	4.24	3.92	0.007*
02	Grey fabric - Twill weave	6.1	2.83		
03	Leaf extract - Plain weave	7.9	4.1		
04	Stem extract - Plain weave	6.8	2		
05	Leaf extract - Twill weave	7.8	5.37		
06	Stem extract - Twill weave	0.6	0.28		

*-Significant at 5% level

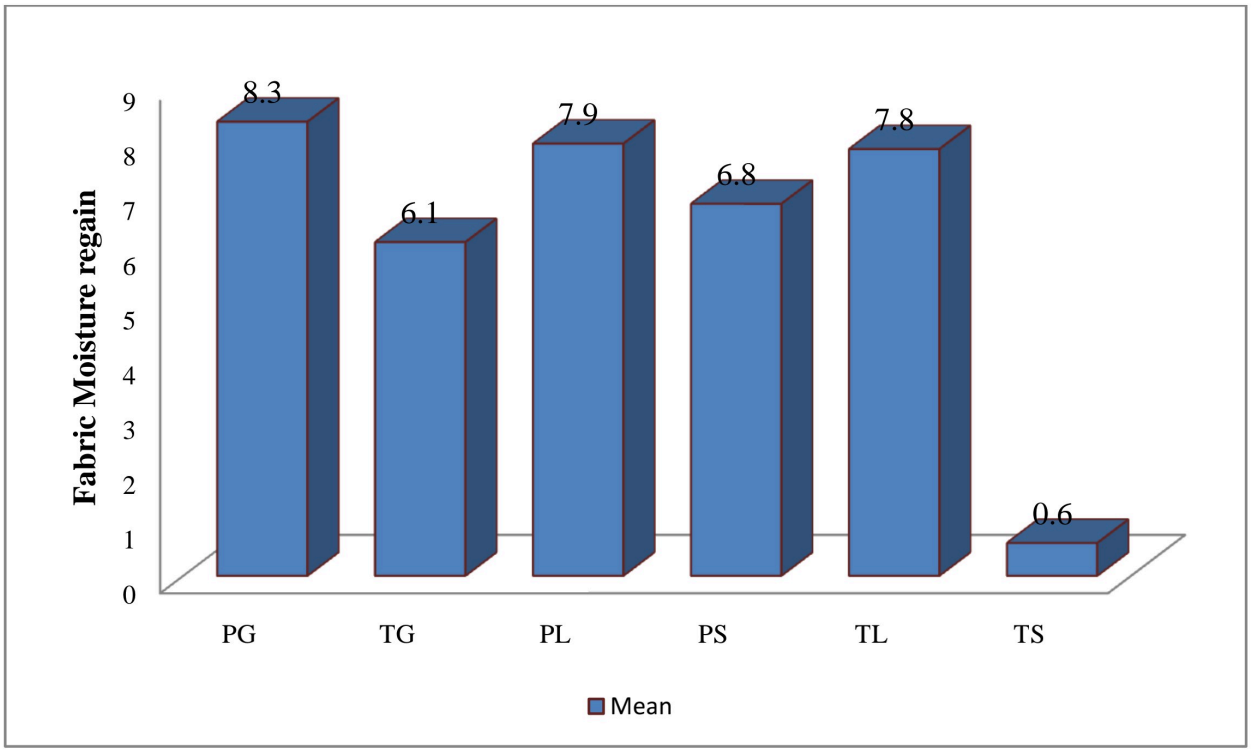


Figure - 26

Fabric Moisture regain

As per the table 16, the Mean value of picks per inch Sample of PG, TG, PL, PS, TL, and TS are 8.3, 6.1, 7.9, 6.8, 7.8, and 0.6 respectively. There is an increase in the moisture content value of TL compared to TG because of the deposition of extract components onto the fabric and the twill weave being courser than plain weave and rest all other finished fabrics compared to the grey fabric have decreased because of desizing them and treating them to give an antimicrobial finish. TS has the least moisture regain value. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 3.92.

4.2.4.3 Fabric Spray test - Table 17: Anova for Fabric Spray Test

No.	Sample	Mean	Standard deviation	F - Test	P value
01	Grey fabric - Plain weave	58	36.2	3.1	0.023*
02	Grey fabric - Twill weave	38	21.21		
03	Leaf extract - Plain weave	20	7.07		
04	Stem extract - Plain weave	74	42.4		
05	Leaf extract - Twill weave	34	15.88		
06	Stem extract - Twill weave	62	31.1		

*-Significant at 5% level

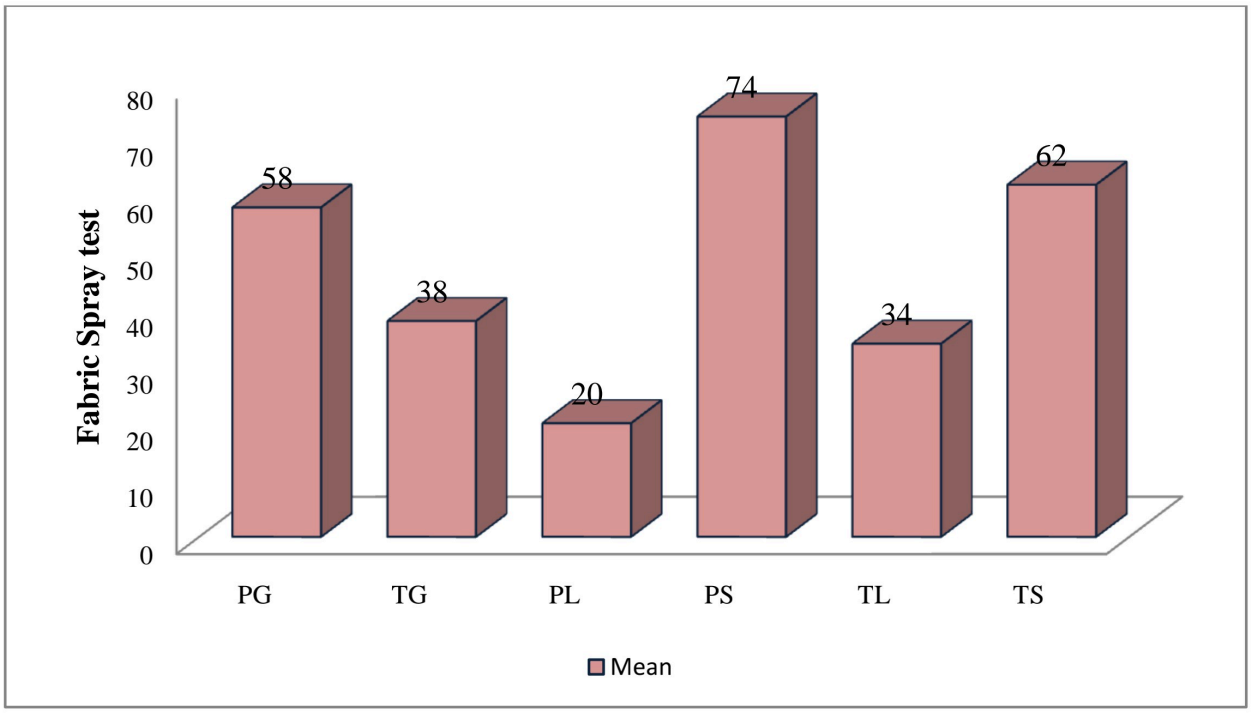


Figure – 27

Fabric spray test

As per the table 17, the Mean value of picks per inch Sample of PG, TG, PL, PS, TL, andTS are 58, 38, 20, 74, 34, and 62 respectively. There is an increase in the value of PS and TSfinished fabrics compared to the grey fabric and decrease in the value of PL and TL because of desizing them and treating them to give an antimicrobial finish. The sample PL and TL has more absorbency property than PS and TS. Statistical analysis also proves a significant difference at a 5% level between the samples with an F value of 3.1.

4.2.5 Functional evaluation

4.2.5.1 Anti-bacterial activity

Table 18: Antibacterial activity of Leaf and Stem extract finished fabrics

S.no	SAMPLES	Zone of inhibition (mm)	
		Escherichia coli	*Staphylococcus aureus*
01	Grey fabric - Plain weave	0	0
02	Grey fabric - Twill weave	0	0
03	Leaf extract - Plain weave	36	37
04	Stem extract - Plain weave	37	38
05	Leaf extract - Twill weave	37	37
06	Stem extract - Twill weave	37	36

Inference

1. Sample-03: Herbal extracts finished fabric swatches showed GOOD antibacterial activity of about 36mm inhibitory zone against *Escherichia coli* and 37mm inhibitory zone against *Staphylococcus aureus*.
2. Sample-04: Herbal extracts finished fabric swatches showed GOOD antibacterial activity of about 37mm inhibitory zone against *Escherichia coli* and 38mm inhibitory zone against *Staphylococcus aureus*.
3. Sample-05: Herbal extracts finished fabric swatches showed GOOD antibacterial activity of about 37mm inhibitory zone against *Escherichia coli* and 37mm inhibitory zone against *Staphylococcus aureus*.
4. Sample-06: Herbal extracts finished fabric swatches showed GOOD antibacterial activity of about 37mm inhibitory zone against *Escherichia coli* and 36mm inhibitory zone against

Staphylococcus aureus.

Further studies needed to determine the durability of Samples using AATCC 124 wash durability test method as future study.

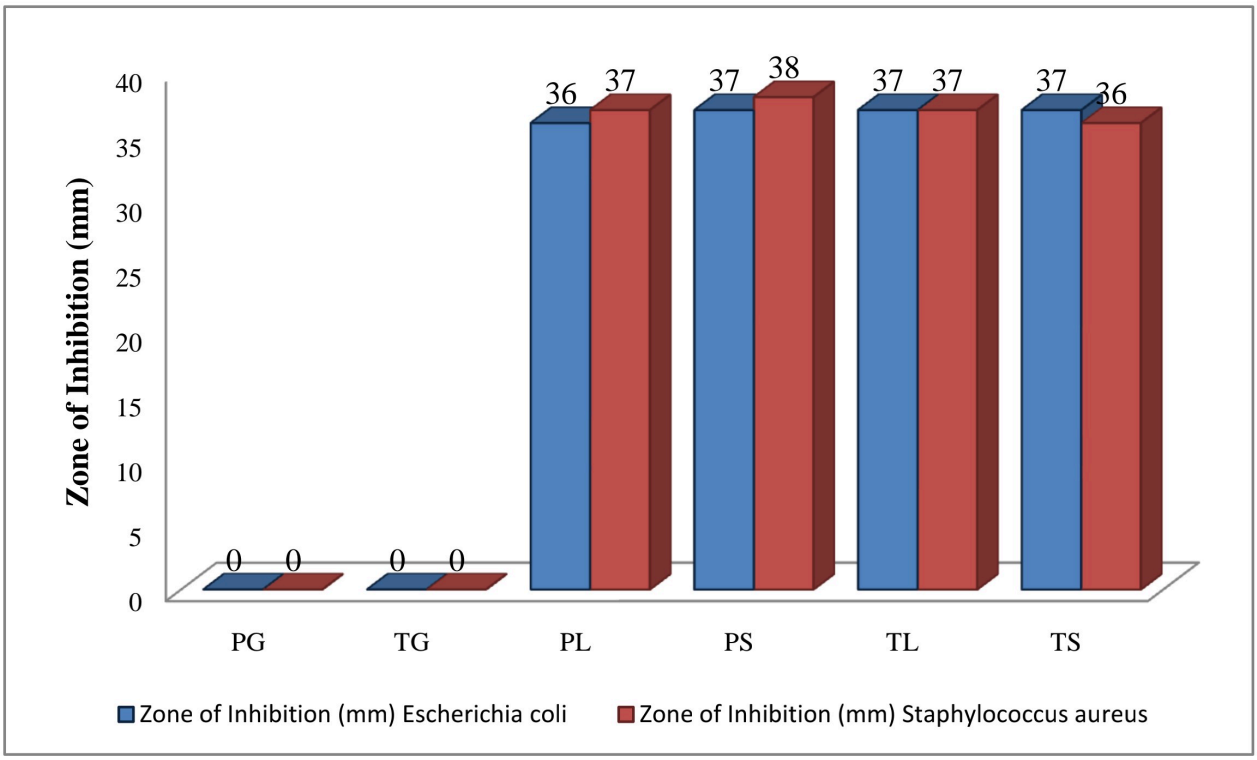


Figure 28: Zone of inhibition by *Escherichia coli* and *Staphylococcus aureus*

4.2.5.2 Anti-fungal activity

Table 19: Antifungal activity of Leaf and Stem extract finished fabrics

S.no	SAMPLES	Zone of inhibition (mm)	
		Candida albicans	*Candida tropicalis*
01	Grey fabric - Plain weave	0	0
02	Grey fabric - Twill weave	0	0
03	Leaf extract - Plain weave	37	38
04	Stem extract - Plain weave	36	38
05	Leaf extract - Twill weave	36	37
06	Stem extract - Twill weave	38	37

Inference

1. Sample-03: Herbal leaf extracts finished fabric swatches showed GOOD antifungal activity of about 36mm inhibitory zone against *Candida albicans* and 38mm inhibitory zone against *Candida tropicalis*.
2. Sample-04: Herbal leaf extracts finished fabric swatches showed GOOD antifungal activity of about 37mm inhibitory zone against *Candida albicans* and 38mm inhibitory zone against *Candida tropicalis*.
3. Sample-05: Herbal leaf extracts finished fabric swatches showed GOOD antifungal activity of about 38mm inhibitory zone against *Candida albicans* and 37mm inhibitory zone against *Candida tropicalis*.
4. Sample-06: Herbal leaf extracts finished fabric swatches showed GOOD antifungal activity of about 36mm inhibitory zone against *Candida albicans* and 37mm inhibitory zone against

Candida tropicalis.

Further studies needed to determine the durability of Samples using AATCC 124 wash durability test method as future study.

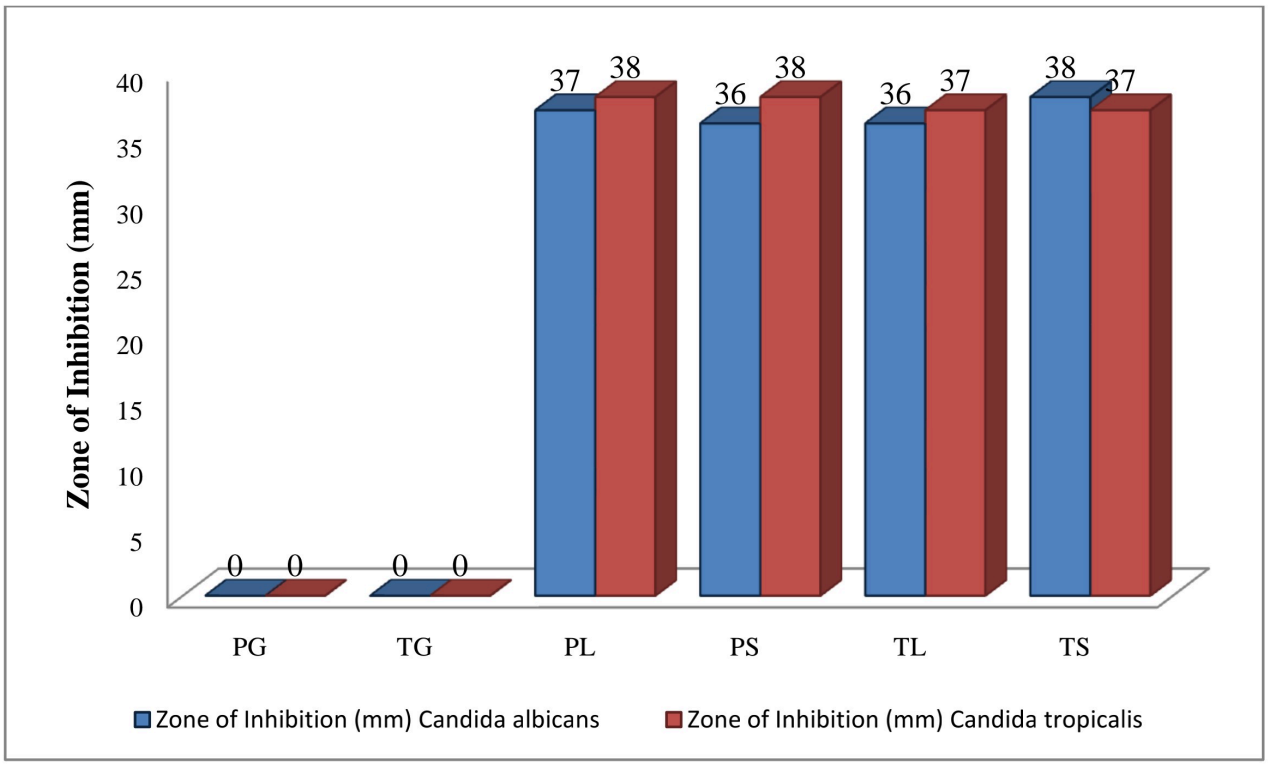


Figure 29: Zone of inhibition by *Candida albicans* and *Candida tropicalis*

SUMMARY AND CONCLUSION

5 SUMMARY AND CONCLUSION

The textile sector holds a particular significance in our country. One of the first to emerge in India, it accounts for 14% of overall industrial production, approximately 30% of total exports, and is the second largest employer after agriculture. Nobody knows where the first cotton fabric was made.

The utility of cotton is dated long ago, from the period of Indus valley civilization till now. Organic agricultural practices restore and protect soil fertility, restrict the use of toxic and persistent pesticides and fertilizers, and encourage biological variety. Third-party certification bodies verify that organic farmers use only techniques and materials permitted for organic production. Organic cotton is grown with no using of toxic and chronic pesticides or artificial fertilizers. So the organic cotton fabric is chosen as the clothing which helps in use of the source over.

Plants were used for medicinal purposes even before the ancient period. The use of herbs is described in ancient Unani writings, Egyptian papyrus, and Chinese literature. Plants have been employed as medicine by Unani Hakims, Indian Vaids, and European and Mediterranean cultures for about 4000 years. Herbs were utilized in healing rituals by indigenous cultures such as Rome, Egypt, Iran, Africa, and America, while others developed traditional medical systems such as Unani, Ayurveda, and Chinese Medicine in which herbal medicines were used systematically. Aloe, Tulsi, Neem, Turmeric, and Ginger are medicinal plants that heal a range of ailments. They are recognized as home remedies in several partsof the nation. Many people utilize Basil (Tulsi) to produce pharmaceuticals, black tea, for pooja, and for other uses in their everyday life. The source that has been selected is *O.tenuiflorum*. So this was extracted with the help of aqueous method of both water and methanol as solvents for the pilot study. The further study of mainstream was continued with methanol extraction and taken up with tests.

The method of extraction is to dry the leaves and stems under the shade for 5 to 7 days at room temperature, then it is coarsely powdered and added with 100% methanol (20g per 200ml) for 24 hrs at room temperature. The solvent is evaporated at 40 degree; hence thecrude extract is obtained.

From this the GCMS analysis (utilizing NIST data) is processed and found that eugenol (13.545%) is majorly present in leaf extract and stigmasterol (9.62%) is evidently found in

stem extract. These both compounds are highly responsible for therapeutic potential.

Furthermore, the extract was taken to Antimicrobial activity test and the method followed is agar well diffusion method. Processed under the 0.5 McFarland turbidity standards, the plates were rotated by 60 degrees (approx.) between each streak using Muller Hinton agar plates. For each bacterium and fungal inoculums the antimicrobial testing was done within 15 mins of applying test samples and the plates were incubated at 37oC in between 24 to 48 hours. Plates were read if growth was continuously reducing after incubation; hence the diameter of zone of inhibition is measured. Here the outcome was from 8mm to 22mm excluding controlled extract.

As for the final product the organic cotton yarn of 20's count is woven into plain and twill fabrics for further finishing of the herbal (*O.tenuiflorum*) extract on them.

This is achieved by exhaust dyeing method where 0.5 ml of Triton-X-100, 100mg of sodium sulphate, and 5ml of the reactive herbal dyes to 10mL of de-ionized water added. Then the suspension is added with 2% concentrated citric acid.

A meter of fabric is immersed and heated at 60oC, after incubating it for 30 mins 100mg of NaCl is dissolved to 10ml of de-ionized water and added to it, further the temperature is raised to 80oC and continuously heated for 30 more mins. The fabric is then rinsed in de-ionized water at 80oC for 10 mins then rinsed and kept inside a convention oven at 105oC till it dries.

So, after finishing, the next process is about antimicrobial activity test over the finished fabrics with 2 bacterial and 2 fungal cultures of Escherichia coli, Staphylococcus aureus and Candida albicans, Candida tropicalis through sterile nutrient agar plates are prepared and allowed to solidify, a 4mm inoculating loop is used with a whole loop of E.coli and S.aureus, those inoculated plates are incubated at 37oC for 24 hours and the test is proceeded. The sameis again continued for the other 2 fungal cultures.

The complete study was to know about the following

- To know the property of *O.tenuiflorum*
- To understand the extraction method of leaves and stems
- To execute a pilot study on extraction process
- To extract the required samples

- To test the antimicrobial activity of it over some bacteria and fungus
- To weave a set of fabric out of cotton
- To finish the fabric with extract and test its antimicrobial activity

The summary and conclusion for the study "A Comparative study on Antimicrobial activity of *Ocimum tenuiflorum* Linn leaves and stem extract on Organic cotton" are provided.

- *First Phase*
- The first phase of the project involves reviewing the literature and finding the properties and characteristics of the source *O.tenuiflorum* to study them and understand different kinds of *Ocimum* and their physical and chemical characteristics. Also, it was based on the other source of the project that is the organic cotton and its characteristics. Getting to know the demographic, geographic conditions and places both grows. The phase also includes studying the importance of the sources used for further process.
- *Second Phase*
- The second phase consists of a pilot study on the source used. So, the source are collected from the Botanical garden, Agricultural University, Coimbatore and tested for authentication from the Botanical Survey of India, Tamil Nadu Agricultural University. The extraction was basically experimented in 2 types which are water extraction and methanolic extraction. The study was to get to know which extraction gives a better result and yield in antimicrobial property. The methanolic extraction gave a better result by analyzing with GCMS and LCMS.
- *Third Phase*
- The third phase is all about moving forward with the selected extraction method, so the source of *O.tenuiflorum* was collected from Perayur, near Thirumangalam which one of the belt that produces good amount of various Tulsi. The extracted Tulsi leaf and stem was taken to a GCMS analysis and was found each had a compound that is responsible for guarding from microbes. Also, the organic cotton yarn was procured from Rajapalayam which is to produce fabric out of it.
- *Fourth Phase*
- The final phase of this project is about fabricating and finishing them. The organic cotton yarn, which is then made into plain and twill woven fabric of 1/1 and 2/2 respectively. The fabric is processed in exhaust method and both the fabrics are finished with Tulsi leaf and stem extracts. After curing them the unfinished and finished fabrics are taken to evaluation of both subjective and objective.

So finally, from the tests and analysis the fabric has been woven with organic cotton yarn and a functional finish of antimicrobial activity was given which was extracted through maceration using methanol.

Findings of the Study

- ✓ The following are the findings concluded for the unfinished and finished; and they are
- ✓ The Appearance of TL is better compared to the rest 3 samples. The texture of TL is better than the other 3 finished samples. The evenness in finishing is better in the TL sample comparatively.
- ✓ There is not much change in the EPI of all four samples compared to PG and TG, having anF value of 4.10. Also, there is not much change in the PPI values too with the F value of 3.84.A slight increase in the weight of the fabric (GSM) occurs but keeping all the samples in the same medium-weight category.
- ✓ There is a slight increase in the thickness of the fabric.
- ✓ The fabric, including the final fabrics, has excellent abrasion resistance. Except for PS, all have a comparable level of wicking property to grey fabric, as well as sinking property.
- ✓ The stiffness property in both the warp and weft direction of PL and PS is more than TL and TS. There is not much color change or staining in wet crocking but in dry crocking, there is light staining.
- ✓ The finished sample TS has the least moisture content and least moisture regaining property. The leaf extract finished samples has good absorbency than the stem extract finished samples.And at last, good control over bacterial and fungal cultures so hence this species of O.tenuiflo-rum can be used as and like other medicinal herbs and plants. As the world is moving towardssustainability and disease free space (especially after Pandemic); hence this kind of fabric willadd to this idea of world becoming much more sustainable.

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6 BIBILIOGRAPHY

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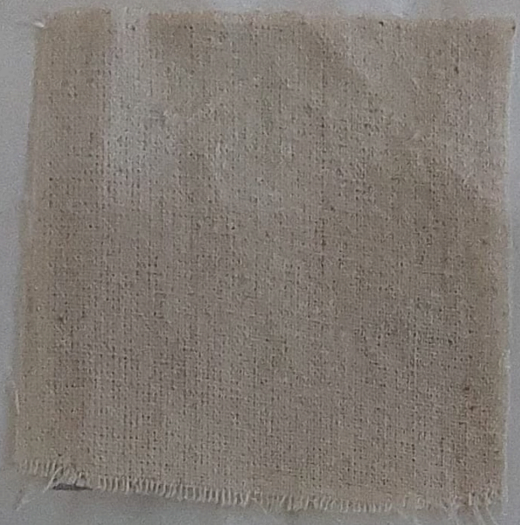
APPENDICES



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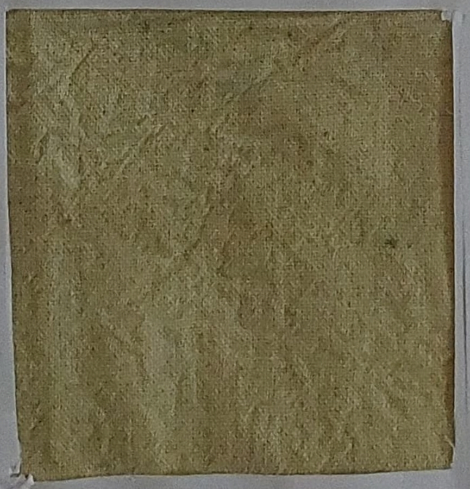

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