Comparative Study of anti-bacterial activity of enzyme treated cotton fabrics with microencapsulated "*mimosa pudica*" and "*aloe barbadensis miller*"extracts

BY

LAVANYA.R

(16PBX003)

A Thesis submitted to the

Avinashilingam institute for home science and higher education for women

Coimbatore – 641043

In partial Fulfilment of the requirements for the

Degree of Master of Science

In

Bio-textiles

April 2018

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Certified as Bonafide Research Work

Signature of the Head of the Department

Signature of the Guide

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1. Introduction

Cotton is considered as the backbone of the world's textile trade. Cotton is the most important natural fibre and it accounts for about 50% of the total world production fibre (Singh, 2000). It is known as the king of fibres and white gold. It has many unique qualities and countless end uses which makes it as one of the most widely used textile fibres in the world (Rupesh, 2012). Cotton is the most widely used natural cellulosic substrate.Owing to the demands of global consumer the researches are being carried out for new ecofriendly processes. Bio-technology process has wider applications in the textile industry and the use of enzymes in processing natural textiles has also increased. Enzymes natural catalysts are the biological tools for development of new biotechnology-based solutions for textile wet processing. Enzymes are widely used in the textile industry due to their eco-friendly nature and sustainability of application on different substrates under varying application conditions. This is also a part of white biotechnology which is aimed at eco- friendly applications and using renewable resources, (Ashok, 2012).

One of the processing steps involves sizing of yarn (coating of the warp threads by starch) in order to prevent their breakage during subsequent weaving. Generally, the sizing agents are selected depending on the quality of yarn and the fabric construction. The typical sizing agents used is natural starch and modified starch derivatives, polyvinyl alcohol (PVA), Carboxyl methyl cellulose (CMC), etc. During the subsequent process this applied size (surface coating on yarn) has to be removed from woven fabric for further wet processing comprising bleaching, dyeing, printing and finishing. The removal of starch from yarn surface is termed as "desizing". Traditionally, desizing was carried out by treating the fabric with water or by chemicals such as acids and oxidising agents.Enzyme desizing is the most widely practiced method of desizing starch. Amylase is a hydrolytic enzyme which catalyses the breakdown of dietary starch to short chain sugars, dextrin and maltose. The advantage of these enzymes it is used as a removing that they are specific for starch, removing it without damaging to the support fabric (Ahlawat, 2009).

Cotton may contain between 4 and 12% by weight of impurities in the form of waxes, proteins, pectin's, ash, and miscellaneous substances such as pigments, hemicelluloses and reducing sugars. These impurities are removed from the fabric by scouring, since their hydrophobic nature negatively affects the enhancement of the fabric's wettability and absorbency. Bio souring performance can be improved as equal to alkali scouring by

removing non-cellulosic impurities by treating the fabrics with enzymes that target the non-cellulosic impurities. It also avoids high energy consumption and severe pollution problems that are associated with conventional alkaline scouring (Emre, 2004).

Textiles are indispensable part of human life. Natural textile fibers are more susceptible to attack than synthetic fibers. At the same time human skin supports growth of bacteria, because of its metabolic side products (Orhan, 2007). Textiles and clothing are in permanent contact with the micro-organisms from the environment and the human skin (Priya, 2017). Awareness about eco friendliness in textiles is one of the important issues in recent times since textiles are used next to skin and are called second skin (Kaplan, 2001).

In recent years multiple drug resistance in human pathogenic microorganisms have developed due to indiscriminate usage of commercial antimicrobial drugs for the treatment of infectious disease. This scenario forced scientists for searching new antimicrobial products from distinct sources like medicinal plants which are the better source of novel antimicrobial chemotherapeutic agents (Anita, 2016). Plants as a source of medicinal compounds have continued to play a dominant role in the maintenance of human health since ancient times. According to the World Health Organization plant extracts or their active constituents are used as folk medicine in traditional therapies of 80% of the world's population. Over 50% of all modern clinical drugs are of natural product origin (Kirbag, 2009).

Aloe barbadensis Miller (Aloe Vera) belongs to the Liliaceous family, of which there are about 360 species. It is a cactus-like plant that grows readily in hot, dry climates and currently, because of demand, is cultivated in large quantities. The gel of *A. Vera* was used to treat stomach ailments, gastrointestinal problems, skin disease, constipation, radiation injury, inflammatory effect, healing wounds and burns, Ulcer and diabetes. *A. Vera* products are mainly for cosmetic, pharmaceutical, nutraceuticals and food industries.one of the well-known property of aloe Vera gel is wound healing ability. It accelerates many internal and external wound healing process (Aysan, 2010).The gel stimulates cell growth and enhances the restoration of damaged skin. *Aloe Vera* promotes the rates of healing, while in contrast, other studies show that wounds to which *Aloe Vera* gel was applied were significantly slower to heal than those treated with conventional medical preparations (Puspa,2012).It moisturizes the skin because it has a water holding capacity. Aloe gel is perhaps the most widely recognized herbal remedy in the United State today; it is used to relieve thermal burn, sunburn and promote wound healing. In addition, research suggests that Aloe gel can help to

stimulate the body's immune system 6. *A. barbadensis* Miller (*A. Vera*) possessed a number of therapeutic uses viz., anti-inflammatory, immunostimulatory antibacterial, antiviral, antifungal and cell growth stimulatory activity(Devi,2012).

Mimosa pudica Linn is a commonly used herb in Ayurvedic medicine. Mimosa is known as a sensitive plant and it is a small short –lived shrub, it is a common plant grown in moist ground which is locally known as *chuimui* (Sunil, 2012). This plant possess an antibacterial, antifungal, antioxidant, anti-inflammatory, antiasthma tic and analgesic activities(Nisha,2014).This plant extracts possess significant wound healing activity (Kiran, 2011).The extracts of *mimosa pudica* consists of bioactive components such as terpenoids, flavonoids,glycosides,alkaloids,quinines,phenols,tannins,saponins,coumarin(Gandhiraja,2009).The medicinal plants are useful for healing as well as for curing of human diseases because of the presence of phytochemical constituents. Phytochemicals are naturally occurring in the medicinal plants, leaves, vegetables and roots that have defence mechanism and protect from various diseases. Phytochemicals play a vital role against number of diseases such as asthma, arthritis, cancer etc. unlike pharmaceutical chemicals these phytochemicals do not have any side effects (Banu, 2015). Phytochemicals such as vitamins (A, C, E and K), carotenoids, terpenoids, flavonoids, polyphenols, alkaloids, tannins, saponins, pigments, enzymes and minerals that have antimicrobial and antioxidant activity (Mathura, 2009).The presence of bioactive components such as alkaloids , flavonoids and steroids possess good antibacterial activity. A rise in environment concerns and demands for environment friendly processing of textiles has led to the development of many new cleaner and greener technologies (Gunay, 2013). There are many upcoming technologies for the eco processing of textiles, which includes, Enzymatic Finishing of textiles, Plasma Technology, Finishing by Natural products and Microencapsulation. Micro-encapsulation is a process in which small capsules of many useful properties are made by using tiny particles or droplets surrounded by a coating. The material inside the microcapsule is called as the core material whereas the wall is called a shell, coating, or membrane. Usually, microcapsules have diameters between a few micrometres and a few millimetres. This technique is now widely used in Textile finishing also. Many special and functional properties can be imparted to the fabrics by microencapsulating the core material. This core material can be any substance having a special function to perform for the fabric. Microencapsulation of anti-microbial agents is also gaining popularity in sportswear and medical textiles. (Umar, 2011). A vast use of this technique can be witnessed in functional finish fabrics, medical and healthcare textiles, Aromatherapy, Cosmetic textiles and many more finishing techniques.

Cotton materials have different medical and healthcare applications due to their advantages such as biodegradability, softness, affinity to skin and sweat absorption (Bacterial contamination leading to infection is a common problem in hospitals. Therefore, it is mandatory to reduce the transmission of microorganisms by developing medical textile fabrics with antibacterial properties (Zang, 2009). Microbes are very small lives on the earth which can't be seen by the naked eyes. They may be known as micro-organisms like bacteria, fungi, algae and viruses, etc. Warmth and moist atmosphere is very much suitable for bacterial growth. Textile materials are not only related to microorganisms such as pathogenic bacteria, odour generating bacteria and mould fungi, but also good media for growth of microorganisms. Nowadays people are very conscious about hygiene and cleanliness (Sheela, 2007)

An eco-friendly natural antibacterial finish has been prepared from the plant extracts for textile application. The Anti-Bacterial finish has overcome the fact of increasing the bacteria and parasites, by applying it at any of the thing which we used in our daily lives. The finish removes or kills the bacteria and parasites present on the surface of the material or fabric and protect us from different diseases that other faces commonly. Anti-bacterial finish prevents the growth of bacteria, health protecting and preventing diseases **(Silva, 2000).**Considering the above facts in mind the investigator selected to study on **"comparative study of antibacterial activity of enzyme treated cotton fabrics with microencapsulated *mimosa pudica* and *aloe barbadensis miller* extracts"** with following objectives to :

- Select enzymes for pre-treatments process.
- Select herbal source for extraction and finishing application.
- Select suitable finishing technique.
- Study the antibacterial property of finished samples using physical, mechanical, comfort and biological (AATCC-100) testing of fabrics.

2. REVIEW OF LITERATURE

The review of literature pertaining to the study entitled **"Comparative study of Antibacterial activity of enzyme treated cotton fabrics with Microencapsulated *mimosa pudica &aloe barbadensis miller* extracts"** is reviewed under the following headings.

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2.2 Enzymes

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2. REVIEW OF LITERATURE

2.1 Cotton

Cotton is the" king of fibres "cotton is the natural vegetative fibre and it is the oldest and important textile fibre and has a great economic importance as a raw material for textile cloth (Moses, 2005).Cotton is one of the major crops cultivated in India and it is most popular among the natural fibre which is admired by the consumers due to its fascinating feel the comfort and versatility. (Malik, 2007) it is the leading natural crop in agricultural commodity providing income to millions of famers worldwide. Commercial cotton grown in more than 80 countries including Australia, china, Egypt, India, Pakistan.

2.1.1 History of Cotton

The origin of cotton is lost in legend for it is older than the recorded history. Probably it originated in India for it is mentioned in "Rig Veda", written nearly 3,500 years ago. Evidence points to its production in India, china, Egypt and Peru. Spinning and weaving as an industry also began in India with good quality fabric being produced around 1500 BC Indian cotton fabrics were sold in the Mediterranean area from the time of alexander. These were known for their outstanding fineness and quality (Sekhari, 2016)

Samples of cotton materials have been found in Indian tombs dating back to the year 3000 BC. There is some evidence that cotton may have been in use in Egypt in 12000, before the use of flax was known. Cotton became an established article of commerce between Venice and cities of central Europe. During the middle ages, Germany became an important centre of European cotton manufacture. (Gordon, 2002)

2.1.2 Properties of cotton

- The quality of the cotton is based on the length and brightness of the fibre.
- It is hypoallergenic i.e. It does not irritate sensitive skin or cause any allergies and static electricity.
- It is a good conductor of heat.
- It absorbs moisture easily
- It is resistance to moth and mildew.
- It has great affinity to dye.

2.1.3 Uses of cotton

- Cotton is used to make a number of textile products.
- Cotton lint is used in clothing shoe strings, pillow cases, denim, towels
- Linters are used in plastics paper products, films, yarns and cosmetics.
- Most of the t-shirts are made up of cotton.
- Cotton is used in finishing nets, coffee filters, tents etc.
- They are used to produce goods such as bandages, swabs, bank notes, cotton buds and x-rays.
- The cotton seed oil is used for cooking and in products like soap, margarine, emulsifiers, cosmetics, pharmaceuticals, rubber and plastics.

2.1.4 Advantages of cotton

- It has good breathable characteristics
- It is hypoallergenic.
- In summer it prevents your skin from heat.
- Easy washable and can be iron even at high temperature.
- Easy availability and biodegradability.
- Good moisture regains.
- High comfort.
- Excellent fineness and softness.

2.2 Enzymes

2.2.1 Introduction

Enzymes are biological catalysts. They increase the rate of chemical reactions taking place within living cells without themselves suffering any overall change (Palmer,2007) enzymes are proteins composed of amino acids produced by human body and by all plants and animals. In the human body, enzymes are the components that catalyse the chemical reactions that are involved in breathing, digestion, growth, reproduction, blood coagulation, healing and everything else that goes on. In fact, our bodies contain some 3,000 different types of enzymes that are constantly regenerating, repairing and protecting us (Anthony, 2008) Enzymes were discovered in the second half of the nineteenth century, and since then

have been extensively used in several industrial processes. Enzymes are generally globular proteins and like other proteins consists of long linear chains of amino acids that fold to produce a three-dimensional product. Enzymes are extremely efficient and highly specific biocatalysts. Enzymes are biocatalysts and by their mere presence and without being consumed in the process, enzymes can speed up the chemical processes. Enzymes are known to catalyse about 4000, biochemical reactions. Synthetic molecules called artificial enzymes also display enzyme -like catalysis (Sonia, 2012) After the reaction is complete the enzyme is released again ready to start another reaction. Usually most enzymes are used only once and discarded after their catalytic action (Boyer, 2007)

Today enzymes have become an integral part of the textile processing. There are two well established enzyme applications in the textile industry. Firstly, in the preparatory finishing area amylases are commonly used for desizing process and secondly, in the finishing area cellulases are used for softening, bio-stoning, and reducing of pilling property.

2.2.2 Classification of enzymes

Enzymes are classified into six groups according to the reaction being catalysed.

- **Oxidoreductases**

  It catalyses oxidation and reduction of the substrate. E.g. Oxidases, dehydrogenases.

- **Transferases**

  It catalyses the transfer of particular group from one substrate to another.eg. Methyl transferases, amino transferases.

- **Hydrolases**

  It causes hydrolysis reactions and are mostly used in textile industry. They catalyse the hydrolysis of ester, ether, peptide etc.

- **Lyases**

  Lyases cleave a covalent bond like C-C, C-O, and C-N etc. in the substrate and form a double bond on it.

- **Isomerases**

  It changes their substrates to their isomers by intermolecular rearrangement. E.g., cis Trans isomerases.

- **Ligases**

Ligases catalyse the union of two small molecules to form a bigger molecule (Syed, 2015).

2.2.3 Properties of enzymes

Enzymes are typical catalysts and they are capable of increasing the rate of reaction without being consumed in the process. Some enzymes, such as pepsin and trypsin, which brings about the digestion of meat, control many different reactions, whereas others, such as urease are extremely specific and may accelerate only one reaction (Subramanian, 2010)

Enzyme accelerates the reaction by lowering the activation energy of reaction, the enzyme remains intact at the end of reaction by acting as catalyst (Kirov, 2011) Enzymes act only on specific substrate, enzymes used in desizing do not affect cellulose hence there is no loss of strength. Enzymes are easy to control because their activity depends upon optimum condition Enzymes are biodegradable and do not produce toxic waste on degradation hence there is no pollution (Mojsov, 2011)

2.2.4 Advantages of enzymes

- Enzymes emerging as the alternative to the polluting textile processing methods. Enzymes are not only beneficial from ecological point of view but they are also saving lot of money by reducing water and energy consumption which ultimately reduce the cost of production. It seems that in the future it will be possible to do every process using enzymes(Danny,2004)
- The textile industry can greatly benefit from the expanded use of these enzymes as non-toxic, environmentally friendly compounds.
- Enzymatic process can reduce the water consumption power energy, pollution, time, and increasing quality.
- Compare to traditional clean-up methods, the enzymatic process results in cleaner waste water or reduced water consumption, a reduction of energy and time(Ardon,2000)
- Lower discharge of chemicals and wastewater and decreased handling of hazardous chemicals for textile workers.

- Improved fabrics quality.
- More fashion choices longer garment life/wear due to lower damage of original fabric.
- Reduced chemical load, reduced water consumption, lower energy consumption.
- Enzyme is eco-friendlier.

2.2.5 Role of enzymes in textile industry

Textile processing has benefited greatly in both environmental impact and product quality through the use of enzymes. From the 7000 enzymes known only about 75 are commonly used in the textile industry processes (Quandt, 2001) enzymes are secretions of living organisms which catalyse biochemical reactions, enzymes are biocatalysts without which no life in plant or animal kingdom can be sustained (Subramaniam,2012)

The principle enzymes applied in textile industry are hydrolases includes amylases, cellulases, proteases, pectinases, and lipases/esterases, amylases were the only enzymes applied in textile processing until the 1980's (Kuhl, 2001) the potential of proteolytic enzymes was assessed for the removal of wool fibre scales, resulting in improved anti-felting behaviour. Enzymes are used in the textile industry because they accelerate reactions act, only on specific substrates, operate under mild conditions, are safe and easy to control, can replace harsh chemicals and enzymes are biologically degradable.

2.2.5.1 Desizing

Desizing is the process of removing the size material from the warp yarns in woven fabrics. In this reprocess, sizing compounds (already applied to yarns to impart tensile strength) are removed from the greige cloth to make it suitable for dyeing and further processing (Gupta,2002)

Objectives of desizing

- To remove the size materials from the fabric
- To make the cotton fabric more absorbent
- To make the cotton fabrics suitable for subsequent process

2.2.5.1.1 Enzymatic desizing

In the textile industry amylases are used to remove starch-based size for improved and uniform wet processing. For fabrics made from cotton or blends, the warp threads are coated with an adhesive substance known as size.

Amylase is the main type of enzyme used in desizing as it decomposes starch to water soluble components (koslowzki,2012) Amylase is a hydrolytic enzyme which catalyses the breakdown of dietary starch to short chain sugars, dextrin and maltose.

Using amylase enzymes for the removal of starch sizes is one of the oldest enzyme applications, amylases are enzymes which hydrolases starch molecules to give diverse products including dextrin's and smaller polymers composed of glucose units (pervin,2008) The advantage of these enzymes is that they are specific for starch removing it without damaging to the support fabric an amylase enzyme can be used for desizing processes at low-temperature.

2.2.5.2 Scouring

Scouring is the removal of non-cellulosic substances from fabrics (moghe,2006)The untreated cotton contains various non-cellulosic impurities such as waxes, pectin's, hemicelluloses and mineral salts present in the primary cell wall of the fibre these are responsible for the hydrophobic properties of raw cotton and interfere with the aqueous chemical processes on cotton (Freytag & dinze 1999) therefore before cotton yarn or fabric can be dyed it needs to be pre-treated to remove materials that inhibit dye binding. (sarisik ,2004)

Objectives of scouring

- To remove natural impurities such as wax, oil, fats from the fabric.
- To increase the absorbency of the cotton fabric.
- To make the fabric highly hydrophilic.

2.2.5.2.1 Enzymatic scouring

The conventional scouring process involving the harsh environment is slowly being replaced with environment-friendly approach using enzymes. Enzymes are specific and fast in action and small amounts of enzyme often save large amounts of raw materials, chemicals,

energy and water. This work represents a review of enzyme scouring of cotton fabrics. This enzyme removes the non-cellulosic impurities present in the fabric, (Radhai,2011) Such a process would enhance the absorbency of the fabric without appreciable strength loss and also would help in the proper dyeing and finishing of the fabric. In this bio-scouring pectinase destroy the cotton cuticle structure by digesting the pectin and removing the connection between the cuticle and the body of cotton fibre whereas cellulase can destroy cuticle structure by digesting the primary wall cellulose immediately under the cuticle of cotton. Handle is very soft in enzymatic scouring compared to alkaline scouring process. Enzymatic scouring makes it possible to effectively scour fabric without negatively affecting the fabric or the environment. It also minimizes health risks hence operators are not exposed to aggressive chemicals (pawer et al. 2002)

2.3 Natural source

2.3.1 Mimosa pudica

Mimosa pudica is a common plant in moist waste ground, lawns open plantations. It is native from Middle America and now distributed in all tropical areas. (Sunil Mistry, v. Vyas 2012) *Mimosa pudica* locally known as chuimui in malwa region. The generic name Mimosa is derived from the Greek mimos, meaning "mimic", alluding to the fact that the leaves move in response to something moving against them. The plant is distributed throughout in India in moist locality. A diffuse prickly under shrub is about 45-90 cm in height. The specific epithet is taken from the Latin word pudica, meaning bashful or shrinking to contact (Barnaby,2017) This creeping perennial herb has been mentioned as a tribal medicine all over India. Mimosa pudica is known as a sensitive plant due to rapid movement of leaves in response to physical and chemical stimuli (sanayae,2015) It is commonly seen in waste lands, lawns, pastures and along road side. The leaves are very sensitive, pods are often spread by floating in water. Seeds are brown and round with a diameter of 2 or 3mm. Seeds are viable for many years (Srivastava, 2012).

2.3.1.1 Distribution of *mimosa pudica*

Mimosa pudica is native to South America and Central America. Mimosa pudica was first formally described by Carl Linnaeus in species plant arum in 1753. Mimosa is usually a short prickly plant with its branches growing close to ground. It grows up to a height of 0.5 m and spreads up to0.3m. The stem of mimosa is erect, slender, prickly, and well branched. Leaves

are bipinnate pale green in colour with a tendency of closing when disturbed. The leaflets are 15 – 25 pairs acute, bristly usually 9-12 mm long and 1.5mm wide. Flowering occurs from august to October in Indian conditions. Fruits of mimosa are pods, 1.5 – 2.5 cm long, falcate and closely prickly on sutures. [Sunil 2012]

2.3.1.2 Scientific Classification

Kingdom -*Plantae*

Division -*Magnoliophyte*

Class - *Magnoliopsida*

Order -*Fabales*

Family -*Mimosaceae*

Genus -*Mimosa*

Species -*M. Pudica*

2.3.1.3 Medicinal uses of *mimosa pudica*

Ayurveda has declared that its root is bitter, acrid, cooling, vulnerary and used in the treatment of leprosy, dysentery, vaginal and uterine complaints, inflammations, burning sensation, asthma, leukoderma and blood diseases. (Gangai, 2014)

Root- it is bitter, acrid, cooling, vulnerary, and used in the treatment of leprosy, dysentery, vaginal and uterine complaints.

Decoction of root is useful in treating diarrhoea, amoebic dysentery, bleeding piles and fastens the wound healing process. It is mainly used in herbal preparations for gynaecological disorders. It will cure skin diseases. All the five parts of the plant leaves, flowers, fruits, stems, roots, are used as medicines in the healthcare medicines. Recent researches show that the extract of this plant can be used for checking childbirth. (Alam, 2012) It is used to relax the mind and relieve depression mental distress, irritability, amnesia. Several research works been carried out to study about the phytochemical components off mimosa pudica and also about the antimicrobial activity of the plant. (Bhawna, 2015)

Bioactive compounds present in *mimosa pudica*

Terpenoids, flavonoids, glycosides, alkaloids, quinines, phenols, steroids, carbohydrates, tannins, saponins, proteins, anthraquinones(Rajiv,2012)

2.3.2 Aloe Barbadensis miller

Aloe Barbadensis miller also called "the elixir of youth "by the Russians, "the herb of immortality" by the old Egyptians or the harmonious remedy" by the Chinese. (Khan, 2011) this medicinal herb most widely used for its impacts on health and also used widely in the cosmetic industry. This works together in a miraculous way to bring about the treatment or the alleviation of some of the most serious illnesses such as cancer or AIDS (Iqbal, 2011)

Aloe Barbadensis miller is basically an herbal medicine depend on folklore and by experiences of people over a long period of time. Of the medicinal plants, aloes have been used for therapeutic purposes since ancient times. Common names of the plant include aloe, aloe capensis, aloe spicate, aloe Vera, Barbados loe, cape aloe, chirukattalai, curacao aloe, ghai Kunwar.

2.3.2.1 Distribution

The natural range of ***Aloe Barbadensis miller*** is unclear, as the species has been widely cultivated throughout the world. Naturalised stands of the species occur in the southern half of the Arabian peninsula, through North Africa (Morocco, Mauritania, Egypt) as well as Sudan and neighbouring countries, along with the Canary, Cape Verde, and Madeira Islands. This distribution is somewhat similar to the one of Euphorbia balsamifera, Pistacia atlantica, and a few others, suggesting that a dry sclerophyll forest once covered large areas, but has been dramatically reduced due to desertification in the Sahara, leaving these few patches isolated. Several closely related species (or sometimes identical) can be found on the two extreme sides of the Sahara: Dragon trees and Aeonium being some of the most representative examples.

The species was introduced to China and various parts of southern Europe in the 17th century. The species is widely naturalised elsewhere, occurring in temperate and tropical regions of Australia, Barbados, Belize, Nigeria, Paraguay and the US. It has been suggested that the actual species' distribution is the result of human cultivation and that the taxonomy could be doubtful too.

2.3.2.2 Description

Aloe Vera or "aloe barbadensis" is a plant which originated in North Africa and spread to the fertile lands with mild climate. Its physical aspect is similar to that of cactus; the thick rind hides a succulent core formed mostly of water. (Syed, 2011)

The botanical name of ***Aloe Vera*** **is** ***Aloe Barbadensis Miller.*** It belongs to the Liliaceous family, which has about 360 species. Aloe Vera is a cactus like plant that grows readily in hot and dry climate and currently, because of high demand, is cultivated in large quantities. It grows mainly in dry regions of Asia, Africa, America and Europe.

Cosmetics and some medicinal products are made from the mucilaginous tissue at the centre of the ***Aloe Barbadensis Miller*** leaf and are called ***Aloe Barbadensis Miller gel***. This gel is a clear, tasteless, thin, jelly like material. The other part of the plant is a group of specialized cells known as the pericyclic tubules. They occur just beneath the outer green rind of the leaf. These cells produce exudates that consist of bitter yellow latex with powerful laxative-like action2. This plant has yellow flowers. The leaves, arranged in a rosette configuration are triangular and spear like and have thorny ridges (Sahil, 2015)

2.3.2.3 Chemical constituents of the plant

There are over 100 active biological constituents found within aloe3. The plant is a rich source of natural, health –promoting substances:

Polysaccharides: Aloe gel is 99% of water with a pH of 4.5 and is a common ingredient in many non-prescription skin salves. The gel has an emollient polysaccharide, glucomannan. It is a good moisturizer, and is used in many cosmetics. Other poly saccharides such as arabinan, arabinorhamnogalactan, glactan, galactogalacturan, glucogalactomannan and glucuronic acid containing polysaccharides are isolated from the Aloe Vera inner leaf gel part.

Anthraquinones /Anthrones: Aloe emodin, aloetic acid, anthranol, aloin A and B, is barbaloin emodin ester of cinnamic acid are also found in Aloe Vera.

Vitamins/ Minerals: It provides vitamin C, A, E, B, B Carotene, Zinc, Calcium, Copper, Magnesium, Manganese and phosphates.

Enzymes: It contains alliase, alkaline phosphatase amylase catalase, lipase peroxidase and carboxy peptidase enzymes.

Amino acids: It provides 20 of the 22-human required amino acids and 7 of the 8 essential amino acids.

Plant sterols: 4 plants steroids campestrol, cholesterol, bsitosterol and lupeol.

Bioactive compounds in Aloe Vera

Mannans, polymannans, anthraquinone C-glycosides, anthrones and anthraquinones, and various lectins(Islam,2014).

2.3.2.4 Medicinal properties of *Aloe Barbadensis miller*

Aloe Barbadensis miller is anthelmintic, aperients, carminative, deobstruent, depurative, diuretic, stomachic and emmenagogue. Juice is used in skin care medicine, dyspepsia, amenorrhea, burns, colic, hyper adenosis, hepatopathy, splenopathy, constipation, span menorrhea, abdominal tumours, dropsy carbuncles, sciatica, lumbago and flatulence. It is used in ayurvedic formulations as appetite stimulant, purgative, and emmenagogue and anthelminthic, for treating cough, colds, piles, debility, dyspnoea, asthma and jaundice, (Joseph 2010).Traditionally, *Aloe barbadensis miller* gel is used both, topically (treatment of wounds, minor burns, and skin irritations) and internally to treat constipation, coughs, ulcers, diabetes, headaches, arthritis, immune-system deficiencies, (Vogler 1999, Eshun2004). The bioactive compounds are used as astringent, haemostatic, antidiabetic, antiulcer, antiseptic, antibacterial, anti-inflammatory, antioxidant and anticancer agent also, effective in treating stomach ailments, gastrointestinal problems, skin diseases, constipation, radiation injury, wound healing, burns, dysentery, diarrhoea and in the treatment of skin diseases, (Baker1975) *Aloe barbadensis miller* has proved its efficiency from the simplest allergies to the treatment of wounds and skin infections. The efficiency of the herb was also proven in the cases of anaemia, deficiency illnesses, insomnia and depressions and the b-sisterole from the aloe Vera brings about the lowering of the cholesterol level. (khan, 2011)

2.4 Extraction methods

Extraction, as the term is used pharmaceutically, involves the separation of medicinally active portions of plant or animal tissues from the inactive or inert components by using selective solvents in standard extraction procedures. Extraction (as the term is pharmaceutically used) is the separation of medicinally active portions of plant (and animal) tissues using selective solvents through standard procedures.

2.4.1 Aqueous extraction

For optimizing the extraction methods of colour component in aqueous medium, dried and finely cut source material of natural dye is grinded in powdered form and then the colour component is extracted in water employing a standard process. The aqueous extraction of dye liquor is carried out under varying conditions, such as time of extraction, temperature of extraction, pH of extraction liquor, concentration of colour-source material and material liquor ratio (MLR) (Kumar,2010) this process reduces transportation cost of raw materials and also helps to standardize the final product(Ratnapandian,2013)

2.4.2 Soxhlet extraction or hot continuous extraction:

In this method, finely ground sample is placed in a porous bag or "thimble" made from a strong filter paper or cellulose, which is place, is in thimble chamber of the Soxhlet apparatus. Extraction solvents is heated in the bottom flask, vaporizes into the sample thimble, condenses in the condenser and drip back. When the liquid content reaches the siphon arm the liquid contents emptied into the bottom flask again and the process is continued. (Azwanida, 2015). Soxhlet extraction is only required where the desired compound has a limited solubility in a solvent, and the impurity is insoluble in that solvent. If the desired compound has a high solubility in a solvent then a simple filtration can be used to separate the compound from the insoluble substance. The advantage of this system is that instead of many portions of warm solvent being passed through the sample, just one batch of solvent is recycled. This method cannot be used for thermo labile compounds as prolonged heating may lead to degradation of compounds. (Nikhal, 2010)

2.4.3 Acids and alkali extraction

As many dyes are in the form of glycosides there can be extracted under dilute acidic or alkaline conditions. The addition of acid or alkali facilitates the hydrolysis of glycosides resulting in better extraction and higher yield of colouring materials (Muthu, 2014)

2.4.4 Microwave assisted extraction (MAE)

MAE utilizes microwave energy to facilitate partition of analytes from the sample matrix into the solvent (Bank ova, 2007). Microwave radiation interacts with dipoles of polar and polarizable materials (e.g. Solvents and sample) causes heating near the surface of the materials and heat is transferred by conduction. Dipole rotation of the molecules induced by microwave electromagnetic disrupts hydrogen bonding; enhancing the migration of dissolved ions and promotes solvent penetration into the matrix (Christen, 2007) In non-polar solvents, poor heating occurs as the energy is transferred by dielectric absorption only (Rakesh, 2008) MAE can be considered as selective methods that favour polar molecules and solvents with high dielectric constant.

2.4.5 Enzyme-assisted extraction

An alternative approach to classical solvent extraction techniques is the enzyme-assisted extraction: this method is innovative and convenient thanks to the fact that the enzymes catalyse reactions in a specific way without operating under strong conditions that could lead to the degradation of the desired products. In addition, proteins like cellulases, hemicellulases and pectinases disrupt cell wall with the hydrolysis of its components leading to a major permeability and allowing an easier release of the metabolites from plants (sharma, 2012). The application of enzymes such as lipases, proteases, phospholipases, permits to reduce the use of the solvent for the extraction. For oil extraction from plants, cellulase, α-amylase and pectinase are the most used enzymes. These proteins can be obtained from fungi, bacteria, animals, and vegetables or from genetic engineering methods and, thanks to their selective catalysis; they can be used to recover a specific bioactive compound in high yields and in a "green" approach, without wasting too much energy. Nevertheless, there are some limitations due to the cost of the enzymatic approach, the incomplete disruption of the cell wall and the complicated application in a commercial scale because of the different behaviour of the enzymes according to the environmental circumstances such as the amount of oxygen, the variety of nutrients and the operating temperature. This technique has never been applied to *S. repens* extraction.

2.4.6 Ultrasound Extraction (Sonication)

Ultrasound is a special type of sound wave beyond human hearing. Usually, in chemistry it is 20 khz to 100 mhz's Like other waves, it passes through a medium by creating compression and expansion. This process produces a phenomenon called cavitation, which means production, growth and collapse of bubbles. A large amount of energy can produce from the conversion of kinetic energy of motion into heating the contents of the bubble. According to Sus lick and Doktycz (1990), bubbles have temperature about 5000 K, pressure 1000 ATM and, heating and cooling rate above 10^{10} K/s. Based on this principle, UAE has been developed. Only liquid and liquid containing solid materials have cavitation effect. The main benefit of UAE can be observed in solid plant sample because ultrasound energy facilitates organic and inorganic compounds leaching from plant matrix. The procedure involves the use of ultrasound with frequencies ranging from 20 khz to 2000 khz; this increases the permeability of cell walls and produces cavitation. Although the process is useful in some cases, like extraction of rauwolfia root, its large-scale application is limited

due to the higher costs. UAE is seemed to be an effective extraction technique for bioactive compound extraction from herbal plants. (Rostagno et al. 2003) The advantages of UAE include reduction in extraction time, energy and use of solvent. Ultrasound energy for extraction also facilitates more effective mixing, faster energy transfer, reduced thermal gradients and extraction temperature, selective extraction, reduced equipment size, faster response to process extraction control, quick start-up, increased production and eliminates process steps (Chemat et al., 2008).

2.4.7 Solvent extraction

Extraction methods used pharmaceutically involves the separation of medicinally active portions of plant tissues from the inactive/inert components by using selective solvents. During extraction, solvents diffuse into the solid plant material and solubilize compounds with similar polarity Natural sources depending upon their nature can be extracted by using organic solvents such as acetone petroleum ether, chloroform, ethanol, methanol, mixture of water with alcohol and so on. The water alcohol extraction method is able to extract both water – soluble and water insoluble substances from the plant resources. The extraction yield is thus higher as compared to the aqueous method as a large number of chemicals and colouring materials can be extracted.

2.4.7.1 Types of solvents

Successful determination of biologically active compounds from plant material is largely dependent on the type of solvent used in the extraction procedure. Properties of a good solvent in plant extractions includes, low toxicity, ease of evaporation at low heat, promotion of rapid physiologic absorption of the extract, preservative action, inability to cause the extract to complex or dissociate. The factors affecting the choice of solvent are quantity of phytochemicals to be extracted, rate of extraction, diversity of different compounds extracted, diversity of inhibitory compounds extracted, ease of subsequent handling of the extracts, toxicity of the solvent in the bioassay process, potential health hazard of the extract. The choice of solvent is influenced by what is intended with the extract. Since the end product will contain traces of residual solvent, the solvent should be non-toxic and should not interfere with the bioassay. The choice will also depend on the targeted compounds to be extracted (Tiwari ,2010).The various solvents that are used in the extraction procedures are:

2.4.7.1.1 Water

Water is universal solvent, used to extract plant products with antimicrobial activity. Though traditional healers use primarily water but plant extracts from organic solvents have been found to give more consistent antimicrobial activity compared to water extract. Also, water soluble flavonoids (mostly anthocyanins) have no antimicrobial significance and water soluble phenolics only important as antioxidant compound (Tiwari, 2010).

2.4.7.1.2 Acetone

Acetone dissolves many hydrophilic and lipophilic components from the two plants used, is miscible with water, is volatile and has a low toxicity to the bioassay used, it is a very useful extractant, especially for antimicrobial studies where more phenolic compounds are required to be extracted. A study reported that extraction of tannins and other phenolics was better in aqueous acetone than in aqueous methanol(Eloff,2010). Both acetone and methanol were found to extract saponins which have antimicrobial activity

2.4.7.1.3 Alcohol

The higher activity of the ethanolic extracts as compared to the aqueous extract can be attributed to the presence of higher amounts of polyphenols as compared to aqueous extracts. It means that they are more efficient in cell walls and seeds degradation which have non-polar character and cause polyphenols to be released from cells. More useful explanation for the decrease in activity of aqueous extract can be ascribed to the enzyme polyphenol oxidase, which degrade polyphenols in water extracts, whereas in methanol and ethanol they are inactive. Moreover, water is a better medium for the occurrence of the micro-organisms as compared to ethanol (Wondra, 2005). The higher concentrations of more bioactive flavonoid compounds were detected with ethanol 70% due to its higher polarity than pure ethanol. By adding water to the pure ethanol up to 30% for preparing ethanol 70% the polarity of solvent was increased (Bimakr, 2010). Additionally, ethanol was found easier to penetrate the cellular membrane to extract the intracellular ingredients from the plant material(Wang,2010). Since nearly all of the identified components from plants active against microorganisms are aromatic or saturated organic compounds, they are most often obtained through initial ethanol or methanol extraction (Cowan, 2000). Methanol is more polar than ethanol but due to its cytotoxic nature, it is unsuitable for extraction in certain kind of studies as it may lead to incorrect results.

2.4.7.1.4 Chloroform

Terpenoid lactones have been obtained by successive extractions of dried barks with hexane, chloroform and methanol with activity concentrating in chloroform fraction. Occasionally tannins and terpenoids will be found in the aqueous phase, but they are more often obtained by treatment with less polar solvents.

2.4.7.1.5 Ether

Ether is commonly used selectively for the extraction of coumarins and fatty acids.

2.4.7.1.6 Ethanol

It is also known as ethyl alcohol or grain alcohol, is a flammable, colourless chemical compound. Drinks with 0.5% or more ethanol are called alcoholic. When people talk about it, they often name it simply as alcohol. Its chemical formula is C_2H_5OH, also written as C_2H_6O. It is used as a solvent because it can dissolve many other chemicals and is not very toxic Ethanol is a very polar molecule due to its hydroxyl (OH) group, with the high electronegativity of oxygen allowing hydrogen bonding to take place with other molecules. Ethanol therefore attracts polar and ionic molecules. The ethyl (C_2H_5) group in ethanol is non-polar. Ethanol therefore attracts non-polar molecules.

2.4.7.1.7 Dimethyl sulfoxide (DMSO)

Dimethyl sulfoxide (DMSO) is an organosulfur compound with the formula $(CH_3)_2SO$. This colourless liquid is an important polar aprotic solvent that dissolves both polar and nonpolar compounds and is miscible in a wide range of organic solvents as well as water. It has a relatively high melting point. DMSO has the unusual property that many individuals perceive a garlic-like taste in the mouth after contact with the skin (Novak, 2002).

DMSO is used topically to decrease pain and speed the healing of wounds, burns, and muscle and skeletal injuries. DMSO is also used topically to treat painful conditions such as headache, inflammation, osteoarthritis, rheumatoid arthritis, and severe facial pain called tic douloureux. This colourless liquid is an important polar aprotic solvent that dissolves both polar and nonpolar compounds and is miscible in a wide range of organic solvents as well as water. It has a relatively high melting point.

2.5 Phytochemical analysis

The medicinal plants are useful for healing as well as for curing of human diseases because of the presence of phytochemical constituents (nostro, 2000). Phytochemicals are naturally occurring in the medicinal plants, leaves, vegetables and roots that have defence mechanism and protect from various diseases. Phytochemicals are primary and secondary compounds. Chlorophyll, proteins and common sugars are included in primary constituents and secondary compounds have terpenoid, alkaloids and phenolic compounds (sarbatly, 2007) Terpenoids exhibit various important pharmacological activities i.e., anti-inflammatory, anticancer, anti-malarial, inhibition of cholesterol synthesis, anti-viral and anti-bacterial activities (Herpen, 2005) Terpenoids are very important in attracting useful mites and consume the herbivorous insects. Alkaloids are used as anaesthetic agents and are found in medicinal plants.

2.6 Microencapsulation

Microencapsulation is the process of enclosing a substance inside a miniature capsule. Extremely tiny droplets, or particles of liquid or solid material, are packed within a second material or coated with a continuous of polymeric material for the purpose of shielding the active ingredient from the surrounding environment.(madhu,2010)Microencapsulation process helps in converting the liquids to solids, changing the colloidal and surface properties, providing environmental protection, enhanced bioavailability and controlling the release characteristics of different coated materials (Bakan, 1991) These capsules, which range in size from one micron to seven millimetres, release their contents at a later time by means appropriate to the application the ingredients to be coated are referred to as core internal phase(IP) encapsulate or fill whereas terms applied to the coating of the microcapsules include the wall, shell, external phase or membrane. All the three states i.e., solid, liquid, and gases may be encapsulated and affect the size and shape of the capsule. If a solid or a crystalline material is used as the core the resultant capsule may be irregularly shaped. However, if the core material is a liquid, simple spherical capsules, containing a single droplet of encapsulate, may be formed. The capsulated particles produce their required effect when their core material is released (Shekar, 2010)

2.6.1 Microencapsulation in textile industry

- Microencapsulated fabrics are among the latest generation of intelligent textiles.
- Medical application of encapsulation has centred around the delivery of drug treatments through clothing, to patients. One such application involves the delivery of antimicrobial treatments to cut down the bugs causing the hospital super-infection MRSA
- The potential of microencapsulation for use in sportswear, underwear and work wear was soon recognised and now it is becoming a common treatment for fashion clothing(Erkhan,2004)

2.6.2 Application of microencapsulation

- There are many reasons why drugs and related chemicals have been microencapsulated. The technology has been used widely in the design of controlled release and sustained release dosage forms.
- To mask the bitter taste of drugs like Paracetamol, Nitrofurantoin etc.
- Many drugs have been microencapsulated to reduce gastric and other G.I. tract irritations. Sustained release Aspirin(Milani,2002)
- Preparations have been reported to cause significantly less G.I. bleeding than conventional preparations.
- A liquid can be converted to a pseudo-solid for easy handling and storage. E.g. Eprazinone.
- Hygroscopic properties of core materials may be reduced by microencapsulation e.g. Sodium chloride.
- Carbon tetra chlorides and a number of other substances have been microencapsulated to reduce their odor and volatility(huanga,2003)
- Microencapsulation has been employed to provide protection to the core materials against atmospheric effects, e.g. Vitamin A palmitate.
- Separation of incompatible substance has been achieved by encapsulation.
- Cell immobilization: In plant cell cultures, Human tissue is turned into bio-artificial organs, in continuous fermentation processes.
- Beverage production.
- Protection of molecules from other compounds.
- Drug delivery: Controlled release delivery systems.
- Quality and safety in food, agricultural & environmental sectors.

- Soil inoculation.
- In textiles: means of imparting finishes.
- Microencapsulation has also been used to decrease potential danger of handling of toxic or noxious substances. The toxicity occurred due to handling of fumigants, herbicides, insecticides and pesticides have been advantageously decreased after microencapsulation.
- It has been used to protect drugs from environmental hazards such as humidity, light, oxygen or heat. Microencapsulation does not yet provide a perfect barrier for materials, which degrade in the presence of oxygen, moisture or heat, however a great degree of protection against these factors can be provided.

2.6.3 Advantages of micro-encapsulation

- Microencapsulation technology is an effective technique used to control the release properties of active ingredients that prolong the functionality of cosmetic textiles. This paper will address the historical background of microencapsulation technology, its significant advantages and the most commonly used microencapsulation methods. Some typical examples of commercially available microencapsulation based cosmetic textile products will also be examined. Recent applications, as well as potential development in cosmetic textiles production.
- Microencapsulation technologies are used to provide antimicrobial finishing on textiles to take advantage of the controlled-release property of active agents, maximize the selection of antimicrobial agents (as the core or/and shell materials), and prolong the durability of antimicrobial activity against laundering and daily use.
- Coacervation is a mature microencapsulation technique used to prepare microcapsules in an oil-in-water or water-in-oil medium for antimicrobial treatment. Besides chemically synthesized biocides, the encapsulation of extracts from natural plants, which are less likely to cause biocidal resistance, is becoming popular and is applied onto textile surfaces. Microcapsules then can be applied on the fabric by exhaustion, padding, printing, or spraying methods. Various natural ingredients like lavender, rosemary, and sage oil have been microencapsulated, which can be used in various products including cosmetic textiles.
- These active core materials sometimes also serve as a fragrance, as well as deodorizing and insect-resistant agents to provide multifunctional finishes.

2.7 Dyeing technique

2.7.1 Padding Mangle

It is one of the most familiar machines for use in dyeing, pre-treatment or finishing. It is used for application of chemicals or even dyes to the fabric in a uniform manner in open width form. The completion of the reaction or dye fixing is carried out by batching, steaming, curing etc.

This machine is used in continuous and semi-continuous methods of chemical/dye application to fabrics. It is suitable for application of low substantively dyes or chemicals to fabrics.

Hence, padding mangle is only one part of a process in which chemicals or dyes are transferred to the fabric uniformly. The reaction or dye fixation is carried out separately by a suitable combination of time and temperature in another machine (batching device, steamer, curing chamber etc.)

The mangle consists of two cylindrical rubber bowls with a stainless-steel mandrel. The diameter of bowls is equal with 55-70° shore hardness. The bowls should be perfect cylinders with smooth surface. The size is generally 170-200 cm in length and 30-40 cm in diameter.

In general, the lower bowl is fixed and is driven by an electric motor. The top bowl is mounted on arms pivoted at the side in such a way that there is a gap (~2 cm) between the two bowls when the machine is not in operation. The upper bowl moves by contact friction generated by the pneumatic pressure.

The fabric to be padded is passed through a padding bowl or trough which is situated below and in front of the mangle. The bowl is filled with padding liquor. As the fabric passes through the trough guided by guide rolls, it gets saturated by the liquor. The stage is known as dip. Since the passage time in the liquor is very small, the fabric should be well –prepared and be highly absorbent. In the next step the fabric passes through the bowls in such a way that the squeezing pressure is applied on the saturated fabric, which is known as nip. While the bowls under pressure move in opposite directions in such a way that the fabric is transported forward. The squeezing action of the bowls allows air in the interstices of the fabric to be expelled which in turn is replaced with padding liquor. The liquor is distributed over the entire fabric surface uniformly and the excess squeezed liquor flows back to the trough.

Since the liquor is continuously taken out by the fabric, it needs to be replenished continuously. The level in the trough is maintained by overflow.

2.8 Microorganisms and textiles

Microbes are the tiniest creatures not seen by the naked eyes. They include a variety of microorganisms like bacteria, fungi, algae and virus. Bacteria as unicellular organisms which grow very rapidly under warmth and moisture (Ramachandran,2004) Further, subdivisions in the bacteria family are Gram positive (staphylococcus aureus), Gram negative (E-coli), Spore bearing or non-spore bearing type. Some specific types of bacterial are pathogenic and cause cross infection. Fungi, molds or mildew are complex organisms with slow growth rate. They are part of our everyday live and found everywhere in the environment and on our bodies.Infection by microbes cause cross infection by pathogen and developments of odour where the fabric is worn next to skin (Rajendran, 2004). Textiles are carriers of microorganisms such as pathogenic bacteria, odor-generating bacteria, and mould. These micro-organisms adhere to the textile and may cause (in good growth conditions of temperature and humidity) offensive odours, discoloration, cross-infection or transmission of diseases (i.e. hospital textile) (shiva, 2015) In addition, the staining and loss of the performance properties of textile substrates are the results of microbial attack. Garments of health care workers are important aspect of the environments that can easily become contaminated. One critical factor for transmission of a micro-organisms from a person (patient or health care worker) to the fabrics and then to another person is the ability of that microbe to survive on that surface of the fabric. A few studies have examined the survival of gram-positive bacteria on various surfaces (Rut hazer, 2003) These researchers investigated the survival of these microbes and confirmed survival of days to months. Thus, act as a reservoir for these microbes(Hardy,2004) The spread of HIV and hepatitis viruses by contact of contaminated materials has created increase pressure for protection of personnel with functional clothing(Deepti,2001).today textile materials are used widely in various environments and antimicrobial treatment is rapidly becoming a prerequisite for textile goods used in hospitals, hotels, sports, and personal care industries(mohammed,2013)it is also observed that microorganisms cause degradation of polymer chains of textile material bringing down the strength and durability of such products. Hence textiles finished with antibacterial finishes are preferred by the modern consumer (prabhu, 2014).

2.8.1 Antibacterial finish

With the growing public health awareness of the pathogenic effects, malodors and stain formations caused by microorganisms, there is an increasing need for antibacterial materials in many application areas like medical devices, health care, hygienic application, water purification systems, hospital, dental surgery equipment, textiles, food packaging, and

storage.(Shahidi et al, 2007) Textile goods, especially those made from natural fibres, provide an excellent environment for microorganisms to grow, because of their large surface area and ability to retain moisture. Most textile materials currently used in hospitals and hotels are conductive to cross infection or transmission of diseases caused by microorganisms. Practically every class of chemical compound has been utilized to impart antibacterial activity to textiles. Two different aspects of antimicrobial protection provided by chemical finishes can be distinguished. The first is the protection of the textile user against pathogenic or odour causing microorganisms (hygiene finishes). The second aspect is the protection of the textile itself from damage caused by mould, mildew or rot producing microorganisms. Bacteria are not as damaging to fibres, but can produce some fibre damage, unpleasant odours and a slick, slimy feel. Often, fungi and bacteria are both present on the fabric in a symbiotic relationship. (Heywood, 2003; Bellini, 2001)

2.8.2 Applications of Anti-Bacterial Finish:

- Anti-bacterial finishes are employed in medical devices like medical tools, instruments, devices, machines.
- It is also used in health care sector, and devices.
- These finishes shave important role in water purification system.
- In dental hospitals these finishes are profusely used for killing the germs and microorganism.
- These finishes are utilized in hospitals in an exceedingly textile section like: bed sheets, lab coats, gloves, and shoes.
- These finishes have a very important role in meditech.
- These finishes are also used in food packaging systems.

3. EXPERIMENTAL PROCEDURE

The experimental procedure pertaining to the study entitled **"Comparative study of Antibacterial activity of enzyme treated cotton fabrics with Microencapsulated *mimosa pudica*** and ***aloe barbadensis miller*** **extracts"** is carried out under the following headings.

3.1 Selection of fabric

3.1.1 Pre-treatment of the fabric

3.1.1.1 Enzymatic or bio-desizing

3.1.1.2 Enzymatic scouring

3.2 Selection of natural source

3.2.1 Aloe barbadensis miller

3.2.1.1 Extraction of aloe vera

3.2.1.1.1 Aqueous extraction

3.2.1.1.2 Solvent extraction-DMSO

3.2.1.1.3 Methanol

3.2.2 Mimosa pudica

3.2.2.1 Extraction of mimosa pudica

3.2.2.1.1 Aqueous extraction

3.2.2.1.2 Ethanol extraction

3.2.2.1.3 Methanol extraction

3.3 Phytochemical analysis

3.3.1 Test for saponins

3.3.2 Test for flavanoids

3.3.3 Test for tannins

3.3.4 Test for quinones

3.3.5 Test for carbohydrates

3.3.6 Test for steroids

3.3.7 Test for glycosides

3.3.8 Test for alkaloids

3.4 evaluation of antibacterial activity of the plant extract

3.4.1 Agar well diffusion method for MABS

3.4.2 Agar well diffusion method for MPPS

3.5 Microencapsulation

3.5.1 Microencapsulation procedure

3.5.2 Application

3.6 Evaluation of antibacterial activity

3.6.1 Procedure for MABS and MPPS

3.7 Physical and mechanical test

3.7.1 Tensile strength and elongation

3.7.2 Fabric weight

3.7.3 Fabric thickness

3.8 Wettability and absorbency test

3.8.1 Drop test

3.9 FTIR

3. Methodology

3.1 Selection of fabric

Cotton is the worlds most used fibre, it is cool, soft comfortable and principle clothing fibre of world (Singh, 2009) cotton, the most popular among natural fibres, is admired by consumers all over the world for its fascinating feel, comfort and versality to use as home textiles (Vasugi, 2010) cotton fabrics characterized by good wearing qualities, excellent launder ability, high absorbency, good colour fastness, easy dye ability and good pliability. Cotton is still in demand because of its higher degree of comfort and good absorbency property (Deshwal, 2008). Considering the above qualities of cotton, commercially available pure white cotton poplin was selected for the study.

3.1.1 Pre- treatment of the fabric

The aim of the preparatory process is to improve the quality by removing starch from the fabric and makes the fabric suitable for follow up process

3.1.1.1 Enzymatic or Bio-desizing

Recipe

Enzyme – amylase (500ml)

Water – 1000ml

Temperature – room temperature

Time – 24 hours

Procedure

In enzymatic desizing amylase enzyme is used for removing starch from the cotton fabric. At first the woven cotton fabric was desized using amylase enzyme by adding 500ml commercial enzyme in 1000ml distilled water. The cotton fabric is first rinsed in cold water and then dipped in enzyme solution at room temperature for 24 hours. After 24hrs the fabric was removed from the solution and dried in shade.

Bio- Scouring

Scouring is the removal of non-cellulosic substance, added impurities, wax etc. on the surface of the cotton.

3.1.1.2 Enzymatic scouring

Recipe

Enzyme-pectinase

Water-1000ml

Temperature- room temperature

Time- 24 hrs

In enzymatic scouring commercial pectinase enzyme is used for removal of non-cellulosic substance, added impurities, wax from the cotton fabric. The cotton fabric was scoured using pectinase enzyme by adding 500ml enzyme in 1000ml distilled water. The fabric was first rinsed in cold water and then dipped in enzyme solution which was kept in room temperature for 24 hrs after 24hrs the fabric was removed from the solution and dried in shade.

3.2 Selection of natural source

3.2.1 Aloe barbadensis miller

Aloe barbadensis miller plants are well known for their medicinal and healing properties from centuries. A. Vera called as the miracles plant or natural healer (Jothi, 2009) aloe Vera possesses antibacterial, antifungal, antiviral anti-inflammatory properties. Considering the above qualities aloe Vera gel was selected for the study.

3.2.1.1 Extraction of natural source – aloe Vera

Procurement of natural source

Leaves of aloe Vera were collected from the roadsides of in and around Pollachi, Tamilnadu India.

3.2.1.1.1 Aqueous extraction

Mature, healthy and fresh leaves of *aloe barbadensis miller* were washed in the running tap water for five minutes and rinsed with sterile distilled water, then dissected longitudinally and the colourless parenchymatous tissue (aloe gel) was scraped out using a knife by eliminating the fibers. In this aqueous extraction 10 Gms of aloe gel was ground with 100 ml distilled water, this extraction was done at 100°c for 1 hour. The hot solution was filtered through a Whatman no. 1 filter paper; the filtrate was stored and used for dyeing of cotton fabrics.

3.2.1.1.2 Solvent Extraction- DMSO

Mature, healthy and fresh leaves of A. Vera were washed in the running tap water for five minutes and rinsed with sterile distilled water, then dissected longitudinally and the colourless parenchymatous tissue (aloe gel) was scraped out using a knife by eliminating the fibres. The 10gms gel was ground with 100ml DMSO (Reynolds, 2000) using the mortar and pestle and the extracts were kept at room temperature for 12 hrs. Then the extracts were filtered using Whatman No.1filter paper and the filtrate was used to treat the cotton fabric.

3.2.1.1.3 Methanol

To prepare methanolic extract 10gms of aloe gel was ground with 100 ml methanol using the mortar and pestle and the extracts were kept at room temperature for 12 hrs. And then the extracts were filtered using Whatman No.1filter paper and the filtrate was used to treat the fabric.

3.2.2 Mimosa pudica

Mimosa pudica also called sensitive plant or touch me not belongs to the genus mimosa. Mimosa pudica have various biological properties such as anticonvulsant, antimicrobial, and anti-inflammatory. Hence this plant was selected for this study.

3.2.2.1 Extraction of natural source – mimosa pudica

Procurement of natural source

The fresh leaves of *mimosa pudica* were collected from the botanical garden located at Palladam, Tirupur district.

3.2.2.1.1 Aqueous extraction

Freshly collected *mimosa pudica* plant leaves was dried in shade and coarsely powdered, 10gms of the powder was extracted with 100 ml distilled water this extraction was done at 100°c for 1 hour. The hot solution was filtered through a Whatman no. 1 filter paper, the filtrate was stored and used for dyeing of cotton fabrics.

3.2.2.1.2 Ethanol extraction

In this ethanol extraction 10 Gms of dry leaves powder of *m. pudica* and 100 ml of ethanol was added. This extraction was done at room temperature for 12 hrs. After 12 hrs the extracts were filtered using Whatman No.1filter paper and the filtrate was used to treat the fabric.

3.2.2.1.3 Methanol extraction

To prepare methanolic extract 10gms of aloe gel was ground with 100 ml methanol using the mortar and pestle and the extracts were kept at room temperature for 12 hrs. and then the extracts were filtered using Whatman No.1filter paper and the filtrate was used to treat the fabric.

3.3 Phytochemical analysis

To identify the phytochemical in plant, extract chemical tests were carried out. The stock concentration of plant extract 10 mg/ml was used.

Testing of *aloe Barbadensis miller* and *mimosa pudica* extracts

3.3.1 Test for saponins

To 1 ml of extract 5ml of distilled water was added and shaken vigorously. Observed for soaking appearance indicates the presence of saponins.

3.3.2 Test for flavonoids

To 1 ml of extract 5ml of dilute ammonia solution was added, followed by the addition of concentrated sulphuric acid along the sides of the tube appearance of yellow coloration.

3.3.3 Test for tannins

To 1 ml of extract add potassium dichromate solution formation of a precipitate shows the presence of tannins and phenolics.

3.3.4 Test for quinones

1ml of the sample was taken to that aqueous ammonia was added and observed for change in colour of aqueous layer (Rao, 2013)

3.3.5 Test for carbohydrates

To the 2ml of extract, add 1ml of napthol solution and concentrated sulphuric acid through the sides of the test tube. Purple or reddish violet color at the junction of the 2 liquids reveals the presence of carbohydrates (Supriya, 2015).

3.3.6 Test for steroids

To 1 ml of the filtrate 10 % of H2 SO4 was added. Green colour was observed for the presence of steroids.

3.3.7 Test for glycosides

Add a few ml of dilute sulphuric acid to 1ml of the extract solution, boil filter and extract the filtrate with chloroform. The chloroform layer is treated with 1ml of ammonia. The formation of red colour shows the presence of glycosides.

3.3.8 Test for alkaloids

1ml of sample was taken to that few drops of dragon doff reagent was added and observed for orange red colour.

3.4 Evaluation of antibacterial activity of the plant extract

The agar diffusion or qualitative methods are simple when a large number of samples have to be screened. These methods consist of placing the textile samples in contact with nutrient agar (NA) plates containing bacterial cell (Eva, 2012).

3.4.1 Agar well diffusion method for *Aloe barbadensis miller* and *Mimosa pudica* extracts.

According to AATCC 100 method nutrient broth and nutrient agar was used as a nutrient source for bacteria. The prepared nutrient broth and nutrient agar was sterilized using autoclave, the ***E. coli*** bacterium was inoculated into the sterilized nutrient broth in the boiling tube which was kept for 24 hrs. Inside the incubator at 37°C. The gel of aloe barbadensis miller (0.2g) was dissolved in 2ml of methanol, DMSO and in aqueous.20ml of nutrient agar was poured into 3 Petri plates separately which was allowed to solidify. The test organism (E. coli) was evenly swabbed on the surface of the agar plates and the well was cut by gel puncture in the size of 6mm diameter. Then 100µl of each extract was impregnated into the well. The plates were kept in the incubator for 37°C for 24 hrs. The zone of inhibition around the well was measured in millimetre.

3.4.2 Procedure for *Mimosa pudica*

According to AATCC 100 method nutrient broth and nutrient agar was used as a nutrient source for bacteria. The prepared nutrient broth and nutrient agar was sterilized using autoclave, the ***S. aureus*** bacterium was inoculated into the sterilized nutrient broth in the boiling tube which was kept for 24 hrs., inside the incubator at 37°C. The extracts of mimosa pudica (0.2g) was dissolved in 2ml of methanol, ethanol and in aqueous.20ml of nutrient agar was poured into 3 Petri plates separately which was allowed to solidify. The test organism (***S. aureus***) was evenly swabbed on the surface of the agar plates and the well was cut by gel puncture in the size of 6mm diameter. Then 100µl of each extract was impregnated into the well. The plates were kept in the incubator for 37°C for 24 hrs. The zone of inhibition around the well was measured in millimetre.

3.5 Microencapsulation

Microencapsulation is a rapidly expanding technology. It is the process of applying relatively thin coatings to small particles of solids or droplets of liquids and dispersions. Microencapsulation is receiving considerable attention fundamentally developmentally and commercially.

3.5.1 Microencapsulation procedure

Recipe

TABLE I

s.no	Materials	Grams	Water
1.	Sodium alginate	3gms	30 ml
2.	Calcium chloride	4gms	60ml
3.	AV	3gms	20ml
4.	MP	3gms	20ml

Microcapsules containing extract were prepared by the following methods. First sodium alginate 3% was prepared separately by adding 20 ml water to it and mixes well. Then both the extracts were prepared by adding 3gms of source in 20 ml water. The prepared natural sources were sprayed into separate Petriplates containing calcium chloride (20ml) solution by means of sprayer. The droplets were retained in the calcium chloride solution for 15 minutes. The microcapsules were obtained by filtration. Then these capsules were dried in hot air oven at 45 c for 12 hours. These capsules were used for finishing of cotton fabric.

3.5.2 Application

According to the following recipe both treated samples were finished with the prepared herbal extract microcapsules. About 250 ml of water containing 350gms of capsules was used to finish half meter cotton fabric. The fabric was immersed in the binder solution containing 8% citric acid for 30 minutes at 50c in an oven after 30 minutes the finished samples were removed and then air dried in shade.

3.5.3 Nomenclature

S.NO	NOMENCLATURE	DETAILS OF THE SAMPLE
1	Original sample	OS
2	*Aloe barbadensis miller* finished sample	MABS
3	*Mimosa pudica* finished sample	MMPS

3.6 Evaluation of antibacterial activity

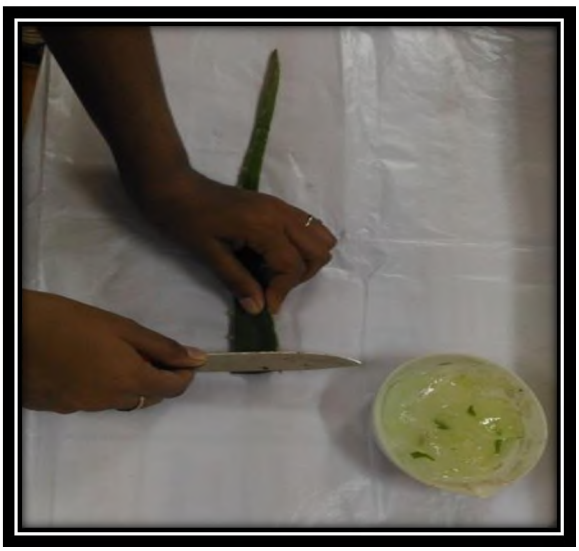
3.6.1 Procedure for MABS and MMPS Samples.

According to AATCC 100 method nutrient broth and nutrient agar was used as a nutrient source for bacteria. The prepared nutrient broth and nutrient agar was sterilized using autoclave, the ***E. coli*** bacterium was inoculated into the sterilized nutrient broth in the boiling tube which was kept for 24 hrs inside the incubator at 37°C.40 ml of nutrient agar was poured into each petriplates which was allowed to solidify. The test organism (E. coli) was evenly swabbed on the surface of the agar plates. The treated samples of both MP and AV were placed on each Petri plates the plates were kept in the incubator for 37°C for 24 hrs. The zone of inhibition around the well was measured in millimetre.

PLATE I

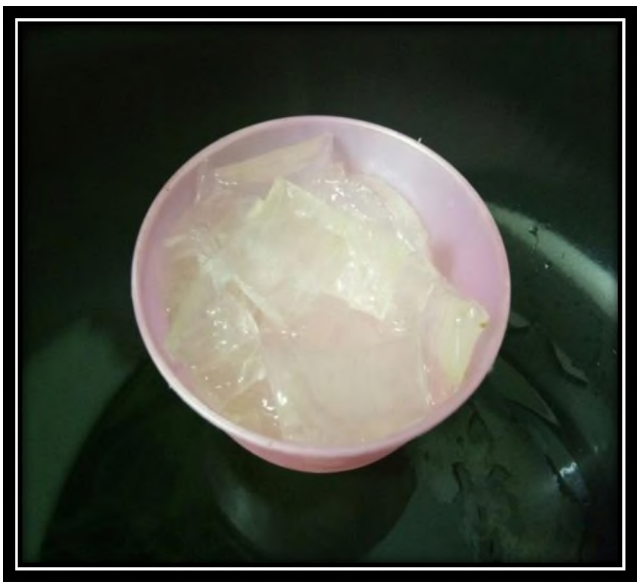
Aloe barbadensis miller

PLATE II



Extraction of aloe gel

PLATE III



Fresh aloe Vera gel

PLATE IV

Fresh leaves of Mimosa pudica

PLATE V

Dried source of mimosa pudica

PLATE VI

Powdered source of mimosa pudica

PLATE VII

Extracted herbal solution of mimosa pudica & aloe Vera gel

PLATE VIII

Phytochemical analysis of Aloe Vera gel and Mimosa pudica extracts

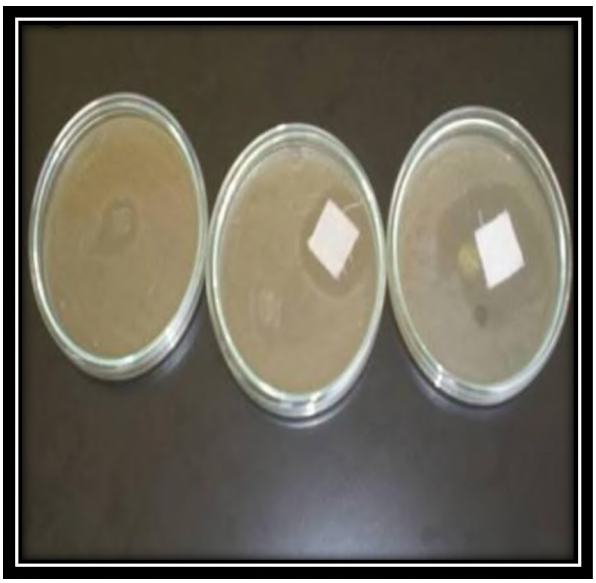
PLATE IX

Microcapsule of herbal extracts

PLATE X

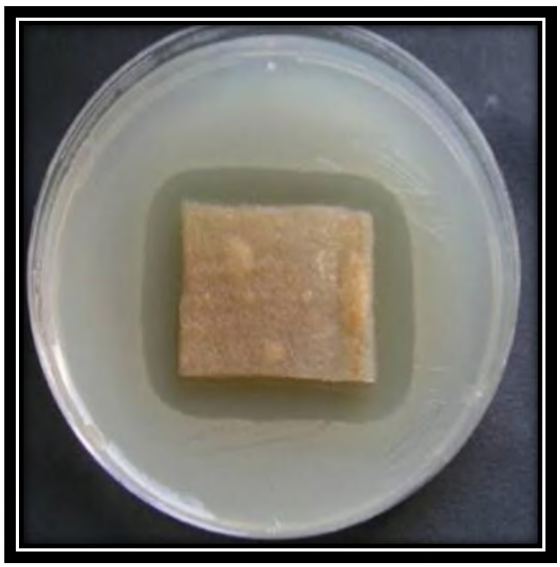
microencapsulation solution

PLATE XI



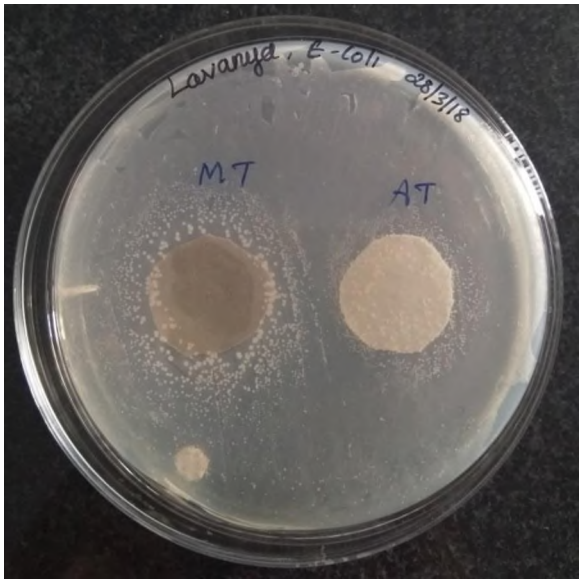
S.AUREUS (MABS)

PLATE XII



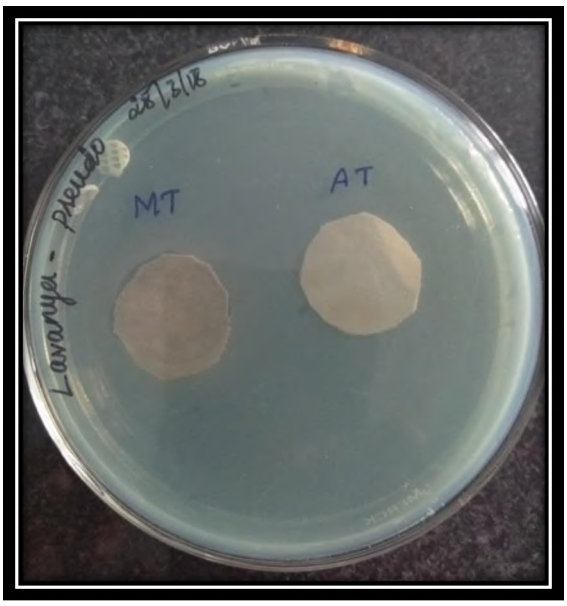
S.AUREUS (MPPS)

PLATE XIII



E.COLI –MABS & MPPS

PLATE XIV



P.AEURIGNOSA –MABS & MPPS

3.7 Physical and mechanical test

Textile testing is the process of inspecting, measuring and evaluating the characteristics and properties of textile materials. Standard test such as fabric weight, fabric thickness, tensile strength and elongation, fabric stiffness, crease recovery, wettability, absorbency tests were carried out for the AV and MP finished samples to study their properties.

3.7.1 Tensile strength and elongation

A measurement of tensile stress - strain properties is the most important mechanical measurement of fabrics. It is used to determine the behaviour of the sample while under an axial stretching load. The tensile strength of fabric was tested according to ASTM Standard – D5035.Instron 5566 is employed to measure the tensile strength of the test sample as specified in ASTM D03-06 standard test method for breaking force ad elongation of textile fabrics. Three samples from both dyed samples of size 12 inches length and 2 inches width were taken. Each sample was clamped tightly between the two jaws. The load was applied until the samples were broken the dial readings in kilograms, elongation in centimetres was noted and the mean value was calculated.

3.7.2 Fabric weight

Fabric weight measurement is always a prerequisite for subsequent tests of other fabric properties specimens of known dimensions are taken by a cutting device or a template to obtain a consistent specimen size (Hu, 2008) grams per square meter is used to find the weight of fabrics. It is a device to cut circular specimen of 100 square centimetre of a fabric very accurately.it has four blades that cut the fabric when the hand wheel is rotated by applying the light pressure. Three samples of both treated samples were cut and weighted accurately using digital balance having 0.01 sensitivity. The values were obtained directly from the readings of the balance. The fabric weight was recorded and the man value was calculated.

3.7.3 Fabric thickness

Fabric thickness is defined as the distance between the upper and lower surface of the material when measured under standard pressure using the Shirley's thickness tester with an accuracy of 0.01mm as explained(stoker,2005) the fabric was placed between the pressure

foot and anvil the reading was noted from the dial. Three readings were taken from different samples of both the treated samples. The mean value was calculated and recorded.

3.8 Wettability and absorbency test

3.8.1 Drop test

This test method is designed to measure the water absorbency of textiles under the AATC/ ASTM Test method TS -018.A burette filled with distilled water was clamped in a stand was mounted in an embroidery frame and was placed at the base of the stand. The distance between the sample and the burette nozzle was kept constant. The nozzle of the burette was opened just to allow a drop of water to fall on the sample. The burette dispenses a drop of water onto the surface of the fabric from a distance of 9.5mm below the burette. The stop watch was started simultaneously and it was stopped when the drop of water absorbs completely. The time taken for this was noted. The same procedure was repeated for three times for both the dyed samples (www.thesmarttime.com)

3.9 FTIR

Fourier – transform infrared spectroscopy (FTIR) is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid or gas. An FTIR spectrophotometer simultaneously collects high-spectral resolution data over a wide spectral range. This confers a significant advantage over a dispersive spectrometer, which measures intensity over a narrow range of wavelengths at a time (Hasseth, 2007)

FTIR relies on the fact that the most molecules absorbs light in the infra-red region of the electromagnetic spectrum. This absorption corresponds specifically to the bond present in the molecule. The frequency range are measured as wave number typically over the range 4000-600cm^{-1} The background emission spectrum of the IR source is first recorded followed by the emission spectrum of the source with the sample in space. The ratio of the sample spectrum to the background spectrum. The resultant absorption spectrum from the bond natural vibration frequencies indicates the presence of organic molecular groups and compounds due to the range of functional groups present in the sample. FTIR is particularly useful for the identification of organic molecular groups and compounds due to the range of functional groups, side-chains and cross-links involved all of which will have characteristic vibrational frequencies in the infra-red range.

4. RESULT AND DISCUSSION

The result and discussion pertaining to the study entitled **"Comparative study of Antibacterial activity of enzyme treated cotton fabrics with Microencapsulated *mimosa pudica* and *aloe barbadensis miller* extracts "**is discussed under the following headings.

4. Result and discussion

4.1 Antimicrobial activity of MABS and MMPS extracts.

4.2 Antibacterial activity of MABS and MMPS extracts

4.3 Physical and mechanical test

4.3.1 Fabric weight

4.3.2 Fabric thickness

4.3.3 Fabric tensile strength

4.3.4 Elongation

4.4 Wettability and absorbency test

4.4.1 Drop test

4.4.2 Spray test

4.5 phytochemical analysis

4.6 FTIR

4. Result and discussion

4.1 Antibacterial activity of MABS AND MMPS Extracts.

The antibacterial activity of MABS and MMPS was tested using agar well diffusion technique. The antibacterial activity MABS and MMPS extracts using different solvents showed varying degree of response towards the selected pathogens was shown in the below table:

TABLE III

S.NO	BACTERIAL STRAINS	ZONE OF INHIBITION (mm)					
		MABS			MMPS		
		Aqueous	DMSO	Methanol	Aqueous	Methanol	Ethanol
1.	***Pseudomonas Aeuroginosa***	8	10	11	6	10	17
2.	***Staphylococcus aureus***	7.5	12	6	6.5	9	13
3.	***Escherichia coli***	7	14	12	8	8.5	15

In MABS sample DMSO extracts exhibited maximum activity against ***E.coli*** (14mm) followed by ***S.aureus*** (12mm). In DMSO extracts the zone of inhibition ranged from 12-14 mm being maximum for ***E.coli*** (14mm) and minimum for ***P.aeuroginosa*** and ***S.aureus***.DMSO extracts shows maximum antibacterial activity which was selected for the further study.

In MPPS sample ethanol extracts shows maximum activity against ***P.aeuroginosa*** (17mm) followed by ***E.coli*** (15mm).in ethanol extracts the zone of inhibition ranged from 13-15mm being maximum for ***P.aeuroginosa*** (17mm) and minimum for ***E.coli*** and ***S.aureus***. Antibacterial activity of MPS samples is due to the presence of flavonoid content in the mimosa pudica extracts.

As a result MMPS (ethanol extracts) shows maximum antibacterial activity (17mm), when compares to the MABS sample (DMSO extracts) which exhibits 14mm inhibition zone

FIGURE 1

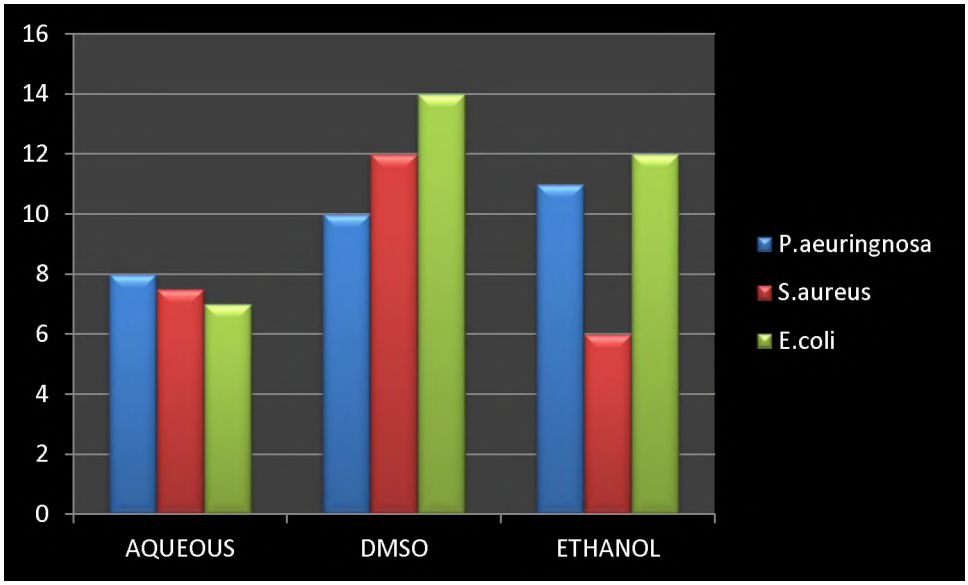
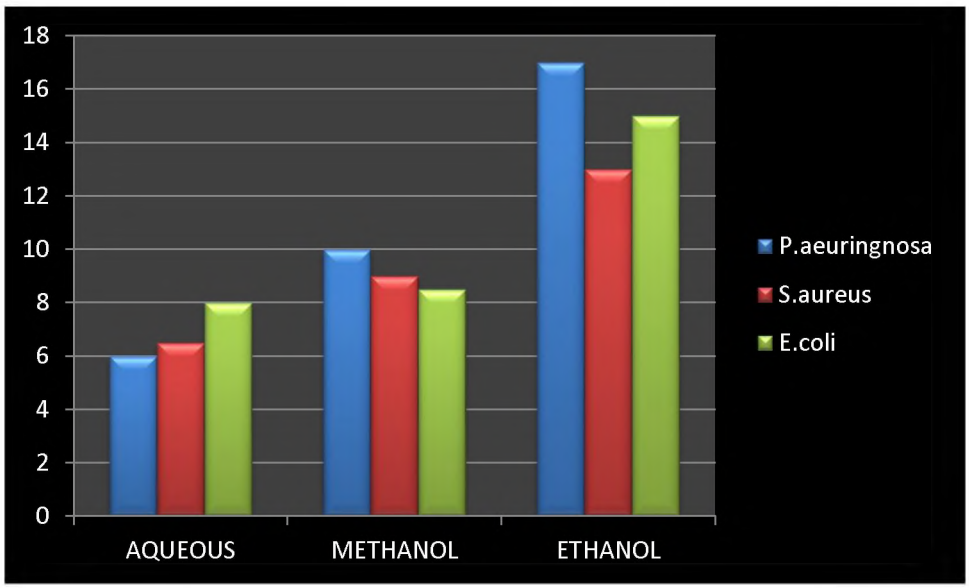


FIGURE 2



4.2 Antibacterial activity of MABS and MMPS extracts.

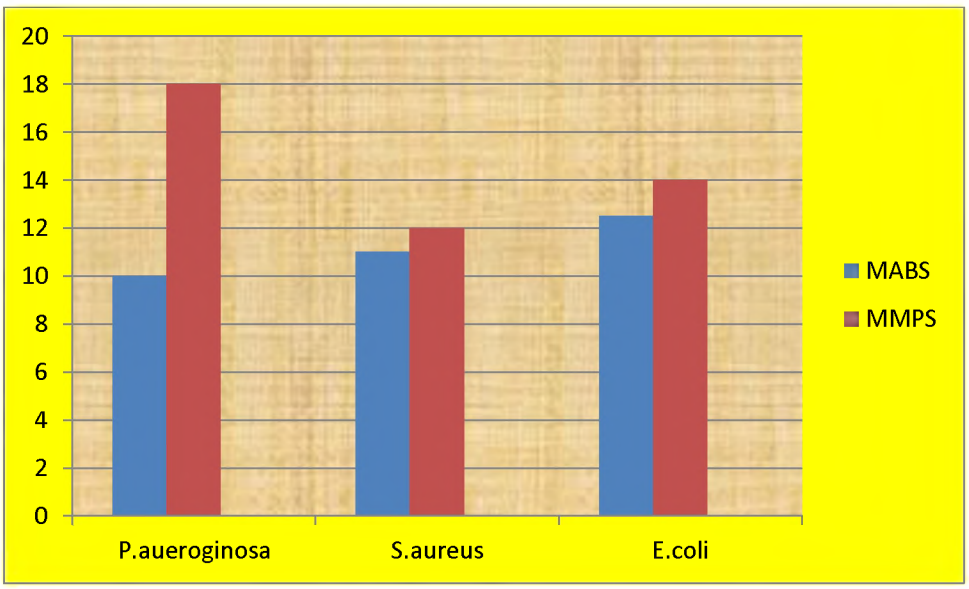
The present study reveals the zone of inhibition of the treated samples against ***Pseudomonas Aeuroginosa Staphylococcus aureus, Escherichia coli bacteria.*** The results are presented below.

TABLE IV

S.no	Test organisms	Assessment of the sample Zone of inhibition (mm)	
		MABS (DMSO extracts)	MPPS (ethanol extracts)
1.	*Pseudomonas Aeuroginosa*	10	18
2.	*Staphylococcus aureus*	11	11
3.	*Escherichia coli*	12.5	12

From the table it is clear that Antibacterial activity of the MABS samples against three organisms such as ***Pseudomonas Aeuroginosa Staphylococcus aureus, Escherichia coli*** show less zone of inhibition when compared to MPPS sample. The maximum zone of inhibition seen in the MPPS sample (18mm).

FIGURE 3



4.3 physical and mechanical tests

4.3.1 Fabric weight

The fabric weight and analysis of variance of the samples OS, MABS and MPPS are shown in table 5 and figure 4.

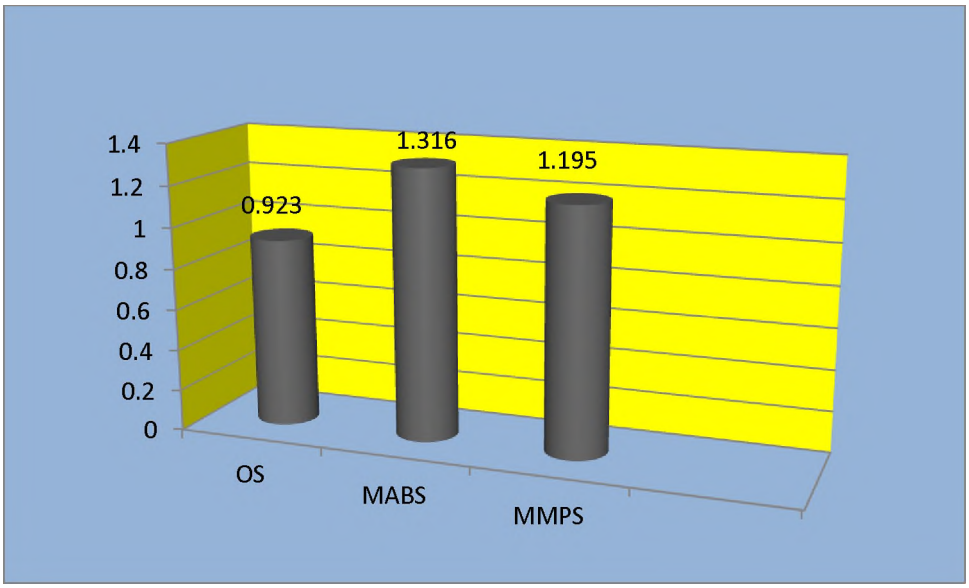
TABLE V

S.no	Sample	Mean value (GSM)	Gain or loss over Original	Percentage of gain or loss over original.	'F' Value
1.	OS	0.923			
2.	MABS	1.316	-0.393	42.579	815.4151**
3.	MMPS	1.195	-0.272	29.505	

** Significant at 1% level.

From the table and figure it is clear that the fabric weight of the sample MABS has increased by 42 % when compared to the original sample. This indicates that the maximum increase in weight was noted in MABS sample followed by MPPS sample.

FIGURE 4



4.3.2. Fabric thickness

The fabric thickness and analysis of variance of the sample OS, MABS and MPPS are shown in the table VI and figure 5

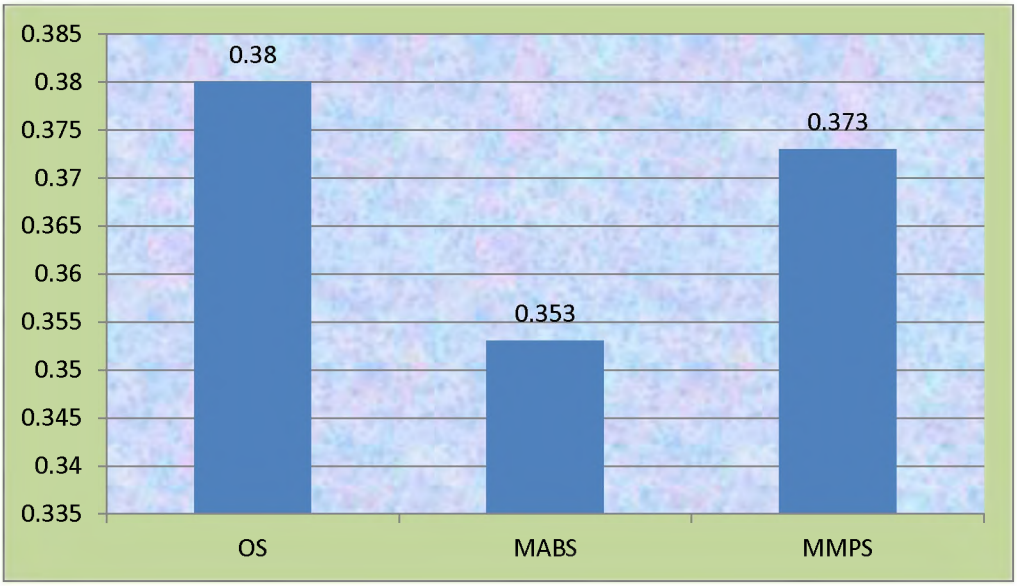
TABLE VI

S.no	Sample	Mean value (mm)	Gain or loss over Original	Percentage of gain or loss over original.	'F' Value
1.	OS	0.380			
2.	MABS	0.353	-0.027	-7.018	1.2683
3.	MPPS	0.373	-0.007	-1.754	

NS – not significant

From the table and figure it is clear that the thickness of samples OS, MPPS has increased when compare to the MABS sample. The result indicates that dye absorption was high in MPPS sample than MABS.

FIGURE 5



4.3.3. Fabric tensile strength

The fabric tensile strength and analysis of variance of the samples OS, MABS and MPPS are shown in the table III and figure 6

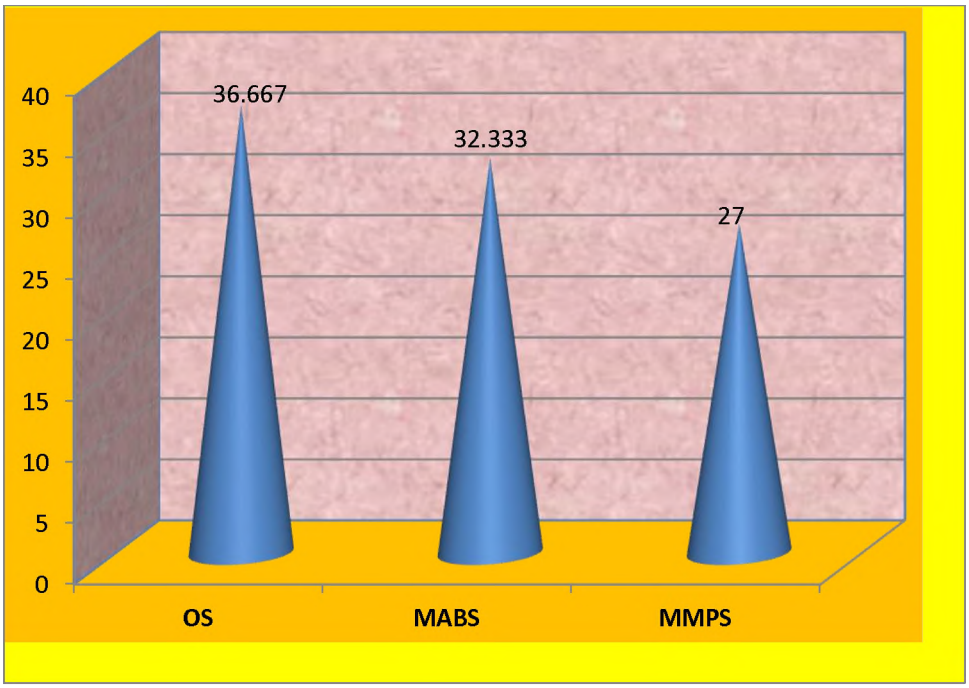
TABLE VII

S.no	Sample	Mean value (lbs.)	Gain or loss over Original	Percentage of gain or loss over original.	'F' Value
1.	OS	36.667			
2.	MABS	32.333	-4.333	-11.818	1.640
3.	MPPS	27.000	-9.667	-26.364	

NS –not significant

From the table and figure it is clear that fabric strength of the samples OS, MABS has increased when compared to the MPPS sample. The increase in fabric strength was maximum in sample dyed with aloe Vera extracts.

FIGURE 6



4.3.4 Elongation

The fabric elongation and analysis of variance of the samples OS, MABS and MPPS are shown in table IV and figure 7

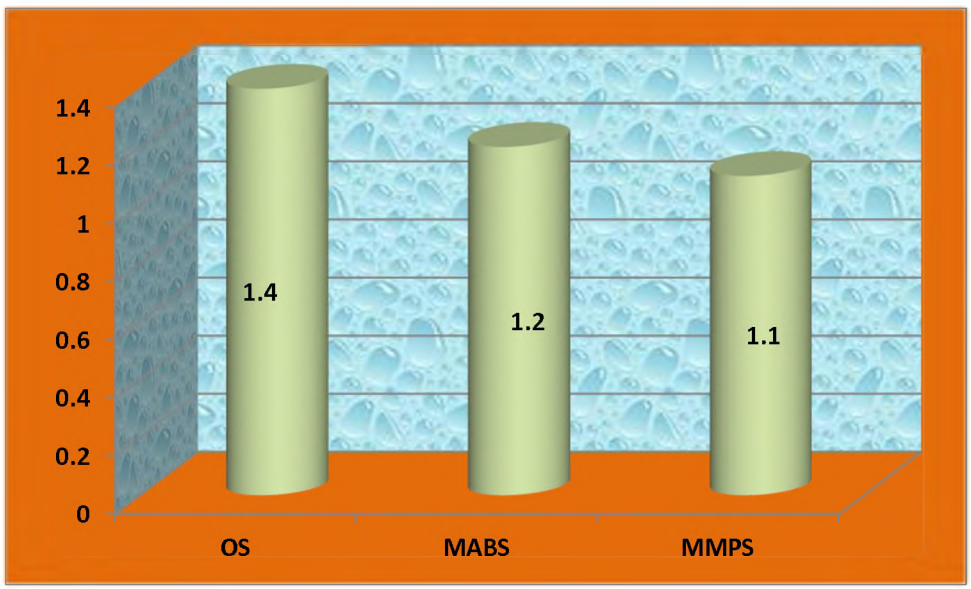
TABLE VIII

S.no	Sample	Mean value (inches)	Gain or loss over Original	Percentage of gain or loss over original.	'F' Value
1.	OS	1.400			
2.	MABS	1.200	-0.200	-14.286	1.075 NS
3.	MPPS	1.167	-0.233	-16.667	

NS- Not significant

From the table and figure it is clear that the fabric elongation of samples OS and MABS has increased when compared to MPPS Sample.

FIGURE 7



4.4 wettability and absorbency test

4.4.1 Drop test

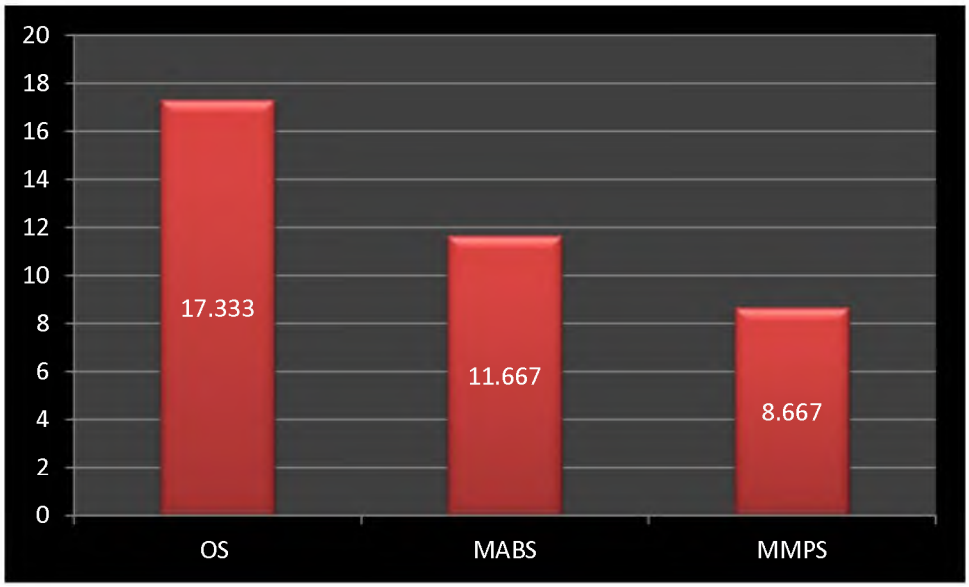
The drop test and analysis of variance of the samples OS, AVS and MPS are shown in the table IX and figure 8

TABLE IX

S.no	Sample	Mean value	Gain or loss over Original	Percentage of gain or loss over original.	'F' Value
1.	OS	17.333			
2.	MABS	11.667	-5.667	-32.692	11.6222**
3.	MPPS	8.677	-8.667	-50.000	

** Significant at 1% level.

FIGURE 8



From the table and figure the results indicates that the absorbency of the dyed samples has increased when compared to the original. Maximum increase in absorbency was noted in MPPS sample followed by MABS sample.

Phytochemical analysis

The extracts of both the samples such as MABS and MPPS of different solvents were studied and their results were tabulated.

TABLE X

S.NO	Phytoconstituents	MABS			MPPS		
		Aqueous	DMSO	Methanol	Aqueous	Methanol	Ethanol
1.	Flavonoids	+	+	+	+	+	+
2.	Saponins	+	+	+	+	_	+
3.	Steroids	_	+	_	_	+	+
4.	Glycosides	_	+	+	+	+	+
5.	Alkaloids	+	+	_	_	+	+
6.	carbohydrates	_	_	+	+	+	_
7.	Quinones	_	_	+	_	_	_
8.	Tannins	_	+	_	_	+	+

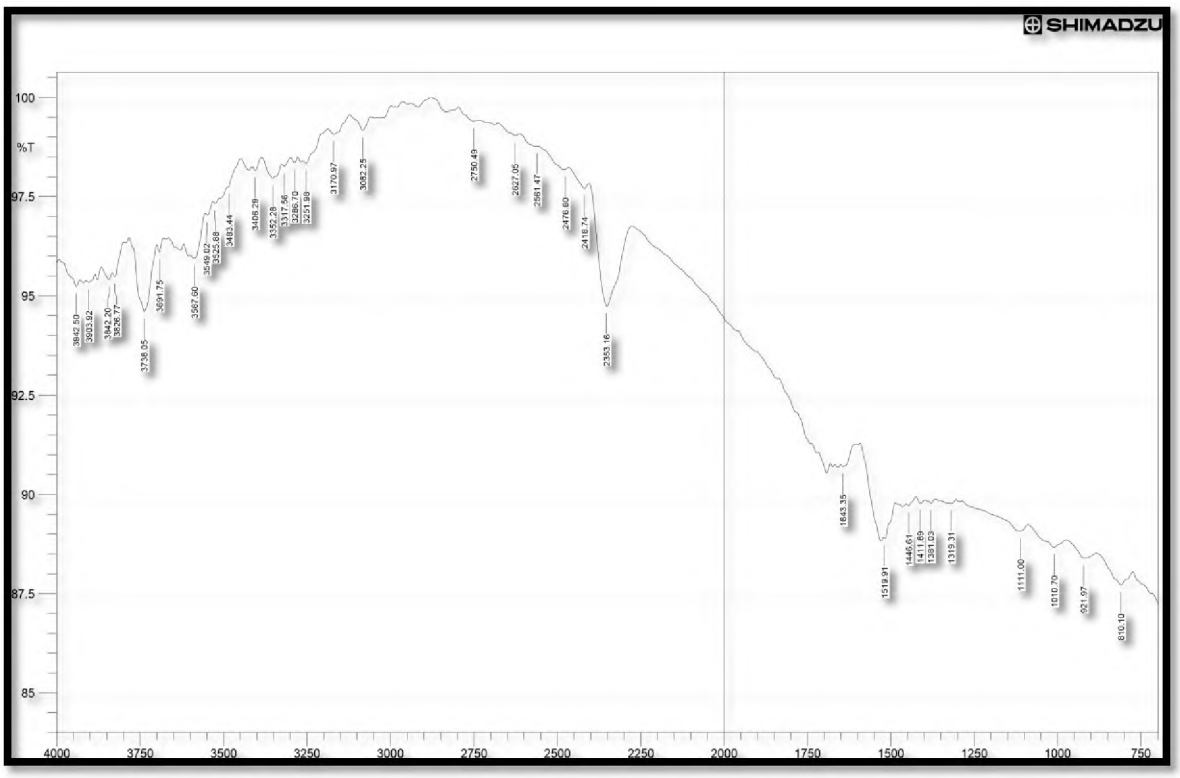
The phytochemical analysis of both MABS and MPPS extracts indicates the presence of flavonoids, saponins, glycosides, alkaloids, in different solvents. Compare to the aqueous extracts solvent extracts shows the maximum presence of phytoconstituents. Presences of flavonoids, alkaloids, tannins, glycosides have possessed good antimicrobial activity.

4.5 FTIR

OS

The figure 9 shows FTIR spectra of OS sample, the peak 3738.05cm^{-1} which represents water OH stretch. The functional group OH hydroxyl group is responsible for the presence of water absorption takes place in the original sample (Reddy, 2015)

FIGURE 9

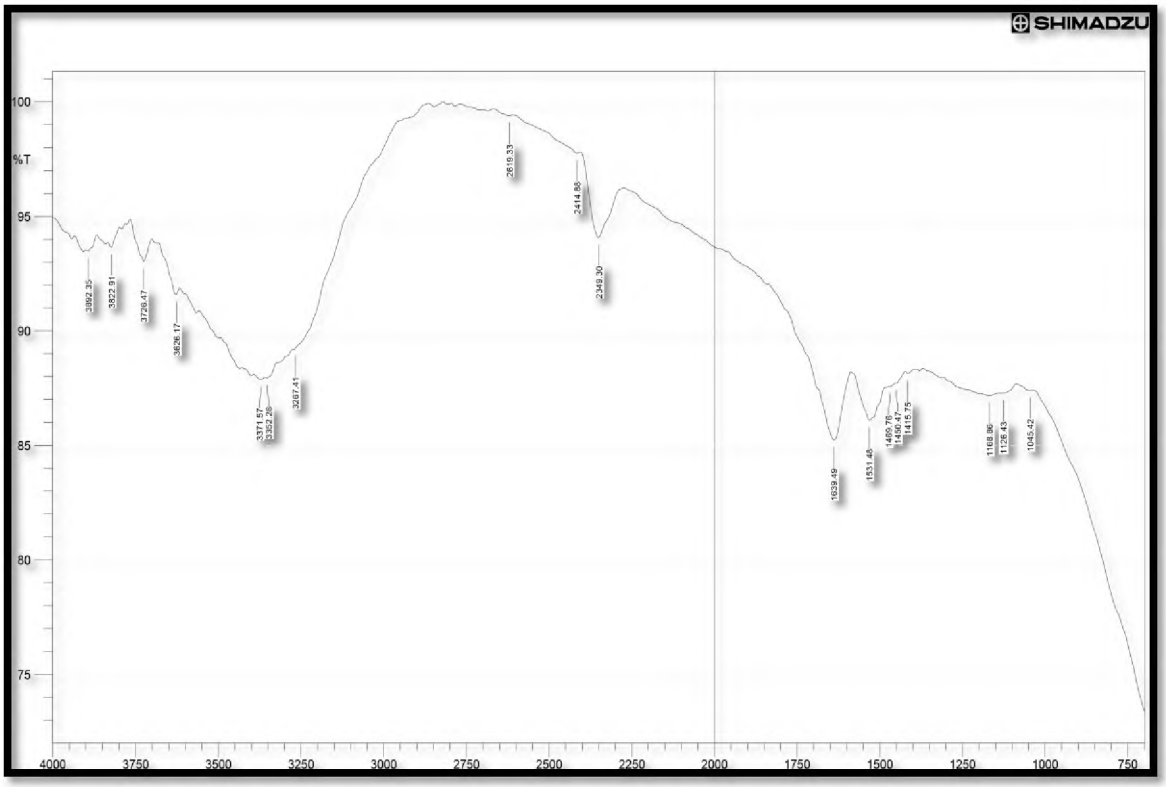


MABS

The figure shows FTIR spectral of AVS sample, the peak 2349.30cm^{-1} which represents C-O Stretching bond (Kannan, 2012).

The FTIR spectra of MABS sample shows peak 2349.30cm^{-1}which represents C-O Stretching bond. The peak 1639.49cm^{-1} corresponds to HOH bonding of absorption (Ramer, 2017) which contains flavonoids; due to the presence of flavonoid this peak shows good antibacterial activity (Sandeep, 2011).

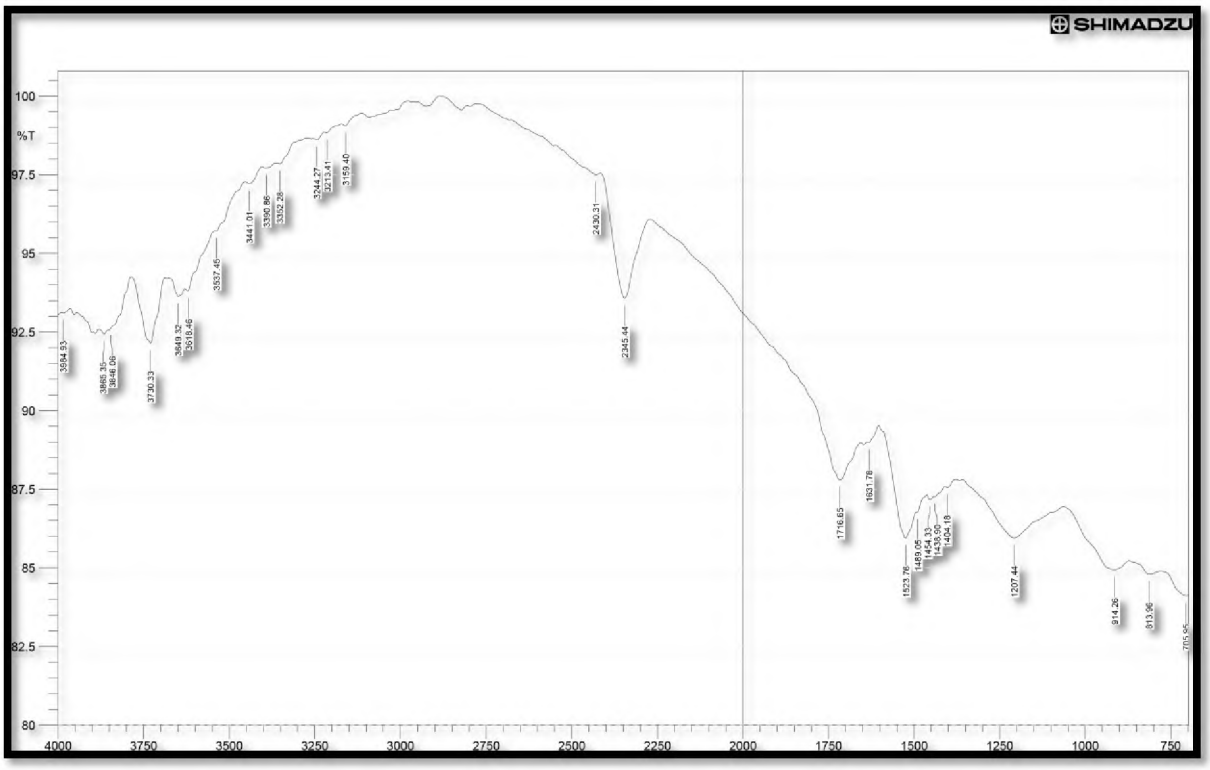
FIGURE 10



MMPS

This figure shows FTIR spectral of MPPS sample the peak 3730.33cm^{-1} which represents water O-H Stretching bond. The FTIR spectra of MPPS sample show peak 2345.44cm^{-1} which represents C-O Stretching bond (Kannan, 2012). The peak 1523.76cm^{-1} represents nitro compound (Naziya, 2014).

FIGURE 11



SUMMARY AND CONCLUSION

The summary and conclusion pertaining to the study entitled **"Comparative study of Antibacterial activity of enzyme treated cotton fabrics with microencapsulated *Mimosa Pudica* and *Aloe Barbadensis Miller"*** is discussed under the following headings.

Enhancement of existing properties and the creation of new material properties are the most important reasons for the functionalization of textiles. To impart the required functional properties to the fibre or fabric, it is customary to subject the material to different types of physical and chemical treatments. These days due to specific use and requirements of the consumer's special purpose finishes are gaining importance, of these antibacterial, flame retardant, water absorbency and soil release are some finishes which are very specific.Owing to the demands of global consumer the researches are being carried out for new eco-friendly processes. Bio-technological process has wider applications in the textile industry the use of various enzymes in processing natural textiles has also increased. In this study enzymatic pre-treatment was carried out due to their eco-friendly nature and sustainability of application on different substrates under varying application conditions. In this present study the natural herbs such as *Aloe barbadensis miller* and *Mimosa pudica* have been chosen for its antibacterial activity. Aloe is a "wonder plant" because it use in multiple problems like antiseptic, anti-inflammatory agent and help in relieving like diabetes, and being a cosmetic field. The aloe plant is need to a greater research emphasis for better utilization of this plant in humankind welfare, it remains for us to introduce to ourselves and thank the nature for its never-ending gift.*M. pudica* is traditionally very important herb having many important pharmacological activities like analgesic, antidiabetic, anti-inflammatory hypolipidemic activity, antimicrobial, hepatoprotective activity, antiasthmatic, anti-ulcer and antioxidant property. Many important phytoconstituents responsible for the activity were isolated. This proves therapeutic importance of the plant, both the natural sources possess good antibacterial activity. *Mimosa pudica* extracts which exhibited antibacterial activity and antiviral activity. It is concluded that both extract could be potential source of active antimicrobial agent(Ranjeet,2013) Hence the present study **"Comparative study of Antibacterial activity of enzyme treated cotton fabrics with microencapsulated *Mimosa Pudica* and *Aloe Barbadensis Miller"*** was carried out with the following objectives to:

- ❖ Select enzymes for pre-treatments process.
- ❖ Select herbal source for extraction and finishing application.
- ❖ Select suitable finishing technique.
- ❖ Study the antibacterial property of finished samples using physical, mechanical, comfort and biological (AATCC-100) testing of fabrics.

Methodology adopted

- Enzymes such as amylase and pectinase were used for the pre-treatment of the cotton fabrics.
- Extraction of both the sources (MABS & MPPS) was done by solvents such as ethanol, methanol, and DMSO (Dimethyl sulphoxide).
- Phytochemical analysis was carried out for both solvent extracts of MABS & MPPS. .
- Before dyeing the natural sources was tested for their antibacterial activity by agar well diffusion method. From these tested solvent extracts ethanol for MABS and DMSO for MPPS was selected for their good antibacterial activity.
- Dyeing of fabrics was done by microencapsulation technique.
- The dyed fabrics were evaluated for their physical, mechanical. Comfort and biological properties.

Findings of the study

- Ethanol and DMSO were found to be the best solvents for extraction of selected sources.
- Enzymes pre-treatment shows good efficiency than conventional methods.
- Phytochemical studies show the presence of bioactive components present in the selected source.
- Fabric weight was found to be increased in MABS sample.
- Fabric thickness was found to be increased in OS and MMPS sample than MABS.
- Fabric strength was found to be maximum in OS and MABS sample compare to MMPS.
- Increase in fabric elongation was maximum in MABS and OS sample.
- Phytochemical testing indicates the presence of flavonoids, alkaloids in the selected extracts.
- The presence of the functional groups such as O-H, C-H is responsible for the anti-bacterial activity.

- Antibacterial activity was found to be increased in mimosa pudica extracts than *aloe barbadensis miller* extracts.

CONCLUSION

The conventional scouring process which utilizes harsh chemicals produce adverse effect on environment. Therefore, many of the developed countries are avoiding the conventional desizing and scouring process, replacing enzymatic, eco-friendly, processes. The enzymatic processing has great future and significant role in minimizing the demand of energy, water, chemicals, time and cost. Enzymes emerging as the best alternative to the polluting textile processing methods. Microencapsulation processes hold the active ingredients inside the capsules and bind with the fibre structure for longer periods when compared with the conventional method of finishing. Microencapsulation technique has enhanced the impregnation of herbal extracts into the cotton fabric. The phytochemical analysis of the crude extracts indicates the presence of active components. Antibacterial activity of the selected extracts might be due to the presence of flavonoids, tannins and alkaloids. The FTIR peaks show the presence of the functional groups such as O-H, C-H which may be responsible for the anti-bacterial activity. The result of this study proved that the extracts of *mimosa pudica* and *aloe barbadensis miller* could be used for antibacterial finishing of cotton fabric. It could be concluded that the extracts of *Mimosa pudica* showed better antibacterial activity when compared to the Aloe barbadensis miller.

Scope for further study:

- Antifungal activity could be assessed in both aloe Vera and mimosa pudica Extracts.
- Wound healing property could be assessed in both aloe Vera and mimosa pudica extracts.
- Efficiency of aloe Vera and mimosa pudica extracts for dyeing different kinds of fabrics could be analysed.

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