# DEVELOPMENT OF ECO-FRIENDLY MOSQUITO REPELLENT AND ANTI BACTERIAL MULTI – FINISHED COTTON NIGHT COAT

**A PROJECT REPORT**

*Submitted by*

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# KUMARAGURU COLLEGE OF TECHNOLOGY

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(INTERNAL EXAMINER)

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## ABSTRACT

In today's era of modernization of the textile industry, we are going through advancements of technology in every field of this industry. The world where this would lead us would be astonishingly hi-tech and materialistic. To ensure our security and safety from the future hazards, we need to equally develop the technology for our protection. With regard to textiles, the protective textile field of the smart textiles has to fulfill this requirement. Today, the value added protective finishes namely Mosquito repellent and Antibacterial textile is one such textile product that protects the human beings from the bite of mosquitoes and micro organisms thereby promising safety from the diseases like malaria and Nile fever and skin allergies. Mosquito transmit deadly disease to humans through their bite. Worldwide, over one million people die each year due to mosquito-borne diseases, most of them young children in sub-Saharan Africa. The controlling and preventing measures for the diseases, a special protective finish of the mosquito repellency using natural medicinal herbs is given to the textile material. In this project an attempt has been made to develop the mosquito repellent and antibacterial cotton night coat. The suitable fabric that has been found is 40's count of cotton with 145 GSM. The fabric has been finished with the natural mosquito repellent herb, **chrysanthemum** which has the property of both antibacterial and mosquito repellency. The herb is extracted with different solvents namely Ethanol and water extracts with different concentrations, temperature and time are used to optimized by Box Beknhen statistical design and the level of antimicrobial activity in herbal solution and fabrics are assessed based on the maximum zone of inhibition by well diffusion and agar diffusion methods. The FTIR results showed the antimicrobial compounds in the herbal treated fabrics. Distilled water is found as suitable solvent for extracting the phytochemical from the flower using dry extraction method. These optimized conditions of herbal extracts can be applied on the fabric by padding and microencapsulation methods with the different cross linking agent alum. The untreated and herbal treated fabrics is tested by standard test methods. The mosquito repellency of herbal finished samples with reference to the untreated sample is tested by U.S. Patent 5,198,287 and USDA Laboratory Method and the results showed 30% good mosquito repellent property . InVitro Cytotoxicity Test showed fabric treated with chrysanthemum extract - is Non toxic at lesser dilution.The standard AATCC 147 and 30 qualitative and AATCC 100 quantitative antimicrobial tests against both bacteria and fungi and objective evaluation tests like tensile strength, Abrasion resistance, Stiffness. Thickness, air permeability, drape, wicking and wetting tests are conducted for the treated and untreated samples. The results showed that the maximum zone of inhibition is found in 2 hr herbal treated fabric with

the mordant alum in the material liquor ratio of 1:20 when compared to 1:10 against staphylococcus and E.coli bacteria. Good antimicrobial property is achieved in the selected herb against staphylococcus (+ve gram) bacteria and E.coli (-ve gram) bacteria and equal zone of inhibition is found against antibiotic. The herbal treated fabric shows better results in all the tests when compared to untreated samples. The micro capsules are analysed in the treated samples by using SEM Study. The application of herbal extract on fabrics lasts up to 12 washes and 22 washes in both pad and micro treated fabrics. Wear study is conducted for more than 10 hrs in the night time with different age groups at Indian Ayurvedic Hospital and Research Limited ,Coimbatore. The mosquito repellency and antimicrobial protective night coat is developed in this project will be best suited for controlling the mosquito bite allergies and fever for human beings and also multi functional and beneficial to the medicinal field.

## 1.0 INTRODUCTION:

In today's era of modernization of the textile industry, we are going through advancements of technology in every field of this industry. The world where this would lead us would be astonishingly hi-tech and materialistic. To ensure our security and safety from the future hazards, we need to equally development the technology for our protection. With regard to textiles, the protective textile field of the smart textiles has to fulfill this requirement. There are over 2500 different species of mosquitoes throughout the world of which 150 species occur in the United States. 52 species occur in California, and 19 species occur in Alameda County. In the course of the District's operation about 10 species are commonly found in the County. Eight of the species account for over 99% of complaints from the public. Each of the species has a scientific name that is latin, such as Culex tarsalis. These names are used in a descriptive manner so that the name tells something about this particular mosquito. Some species have what is called "common names" as well as scientific names, such as Anopheles freeborni, the "Western malaria mosquito". Viral diseases, such as yellow fever, dengue fever and Chikungunya transmitted mostly by Aedes aegypti. Dengue fever is the most common cause of fever in travelers returning from the Caribbean, Central America, and South Central Asia. This disease is spread through the bites of infected mosquitoes and cannot be spread person to person. Severe dengue can be fatal, but with good treatment, less than 1% of patients die from dengue. Basically mosquito repelling textiles are the ones which have a character of repelling mosquitoes. Mosquitoes are dangerous because they carry and transmit disease but not all mosquitoes. 247 million people worldwide each year, and kills nearly one million. Mosquitoes cause a huge further medical and financial burden by spreading yellow fever, dengue fever, Japanese encephalitis, Rift Valley fever, Chikungunya virus and West Nile virus. It is only the female who bites because she needs blood to develop eggs. The males are relatively innocuous and feed on plant nectar and juice. While mosquitoes act as a carrier in transmitting disease, the original host is usually a bird (or occasionally a horse/deer). This feature was developed as a need in sense of protection from the mosquitoes in the areas which are habitats of the mosquitoes and are prone to disease like malaria. To impart this feature, the textile material is given an anti mosquito finish with a natural herb. Plant-based mosquito repellents and antibacterial textiles have been used for generations in traditional practice as a personal protection measure against host-seeking mosquitoes and bacterium. Knowledge on traditional repellent plants obtained through ethno botanical studies is a valuable resource for the development of new natural products. Recently, commercial repellent products containing plant-based ingredients have gained increasing popularity among consumers, as these are

commonly perceived as "safe" in comparison to long-established synthetic repellents although this is sometimes a misconception. To date insufficient studies have followed standard WHO Pesticide Evaluation Scheme guidelines for repellent testing. There is a need for further standardized studies in order to better evaluate repellent compounds and develop new products that offer high repellency as well as good consumer safety. This project presents a summary of recent information on testing, efficacy and safety of plant-based repellents and antibacterial as well as promising new developments in the field of textiles. All natural products will effectively repel mosquitoes, but they require more frequent reapplication (at least every 2 hours) and higher concentrations than DEET. Because of the differences between types of mosquitoes, products that contain multiple repellents tend to be more effective than those containing a single ingredient. Possibly Oils from Verbena, Pennyroyal, Lavender, Pine, Cajeput, Basil, Thyme, Allspice, Soybean, and Garlic etc. Another plant-derived substance, pyrethrum, is an insecticide. Pyrethrum comes from the flowers of the daisy Chrysanthemum cinerariifolium.

The common garden "mum" or chrysanthemum flower has been used in China for centuries for its curative properties as well as an energy tisane, or infusion, to stimulate the blood, according to Herbs 2000. As with many herbs employed in Asian medicine, chrysanthemum has many medicinal uses; among its various properties, chrysanthemum is used to treat infections, for eye problems, to lower high blood pressure, for headaches and colds. This herb is capable of being used on textiles without spoiling their characteristies and has good washing fastness. Chrysanthemum flowers contain a substance that repels mosquitoes and several other insects, including cockroaches, beetles and flies. Products containing the chrysanthemum extract known as pyrethrum work effectively to kill and repel mosquitoes. Natural pyrethrums usually work as an insecticide to kill mosquitoes, but they can also repel mosquitoes. Dispensing a low dosage of pyrethrums into the air slowly poisons mosquitoes in the area, forcing them to leave before they die. In the present day world most of us are very conscious about our hygiene and cleanliness. Clothing and textile materials are not only the carriers of microorganisms such as pathogenic bacteria, odour generating bacteria and mould fungi, but also good media for the growth of the microorganisms. Microbial infestation poses danger to both living and non living matters. Obnoxious smell form the inner spread of diseases, staining and degradation of textiles are some of the detrimental effects of bad microbes. Though the use of antimicrobials have been known for the decades, it is only in the recent couple of years several attempts have been made on finishing textiles with antimicrobial compounds. Anti microbial finish

is a recent innovation in finishes. The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation for a wide range of textile products finished with antimicrobial properties. This finish prevents the growth of bacteria and products finished in it have been proved environment friendly and health protecting, preventing diseases. It also prevents garments from unpleasant odour. Antibacterial finish gives bacterio-static properties to the fabric by inhibiting the growth of bacteria and hence undesirable body odour. The odour development resulting from biological growth on textiles exposed to perspiration had not been considered a real need until relatively recently. To overcome this problem nowadays antiperspirants are used. But antiperspirant shrink sweat glands and block pores causing toxins that are normally eliminated by perspiring .Therefore to control sweating and also to avoid the use of antiperspirants, herbal antimicrobial finishes have been used onto the fabric. Apart from dyeing these medicinal products posses distinct odour for identification. These plant products are non irritant to skin and non toxic. Many of these materials are skin care products. The stem, bark, leaf, root and tubur of the plants and trees can be used for special application. Chrysanthemum flowers have been found to have antibiotic properties under laboratory conditions, leading researchers to think this herb may be effective in the treatment of both staphylococcus and streptococcus bacteria strains. It has been found that it has the good inhibition over the various bacteria.[2]

The present investigation aims at developing eco-friendly natural anti-bacterial finished products from herbal etracts using different solvents, concentrations, temperature and time. The herbal extracts are applied using pad-dry and microencapsulation technique for mosquito repellent and antibacterial property. hence an attempt is made in this study to finish woven cotton fabrics using chrysanthemum with the following objectives

- To develop the natural mosquito repellent textile fabric.
- To arrest the penetration of mosquitoes on fabrics .
- To arrest the metabolism of microbes and controlling of mosquito bites.
- To identify the antibacterial and mosquito repellent efficiency on cotton fabric
- To test the efficacy of mosquito repellency in textile material
- To develop the multi finished cost effective, eco-friendly and saftey mosquito repellent product.

# LITERATURE REVIEW

## 2.0 REVIEW OF LITERATURE:

### 2.1 MOSQUITOES:

The mosquitoes are a family of small, midge-like flies: the Culicidae. Although a few species are harmless or even useful to humanity, most are a nuisance because they suck blood from vertebrates, many of them attacking humans. In feeding on blood various species of mosquitoes transmit some of the most harmful human and livestock diseases. Some authorities argue accordingly that mosquitoes are the most dangerous animals on earth.

Most female mosquitoes have to feed on an animal and get a sufficient blood meal before she can develop eggs. If they do not get this blood meal, then they will die without laying viable eggs. However, some species of mosquitoes have developed the means to lay viable eggs without getting a blood meal.

All mosquitoes must have water in which to complete their life cycle. This water can range in quality from melted snow water to sewage effluent and it can be in any container imaginable. The type of water in which the mosquito larvae is found can be an aid to the identification of which species it may be. Also, the adult mosquitoes show a very distinct preference for the types of sources in which to lay their eggs. They lay their eggs in such places such as tree holes that periodically hold water, tide water pools in salt marshes, sewage effluent ponds, irrigated pastures, rain water ponds, etc. Each species therefore has unique environmental requirements for the maintenance of its life cycle. The feeding habits of mosquitoes are quite unique in that it is only the adult females that bite man and other animals.

#### 2.1.1 TYPES OF MOSQUITOES:

There are approximately 2,700 species of mosquito in the world; the three most significant genera are the Aedes, Anopheles, and Culex, as these types of mosquitoes are responsible for transmitting various diseases that are hazardous to mankind.

##### 2.1.1.1 THE AEDES MOSQUITO:

As one of the most dangerous types of mosquito, the Aedes is anthropophagic, that is, it feeds on the blood of humans. Only the female mosquito bites. It transmits among humans menacing diseases such as yellow fever and dengue fever, and can also cause lymphatic filariasis, an illness that can trigger elephantiasis in certain cases.

Most species of Aedes can be found in the tropical and subtropical zones of the world. Recently, the genus has been discovered in more temperate regions, and its presence can now be anticipated on every continent except Antarctica.

The female Aedes mosquito lays its eggs on the surface of water; adulthood is reached within approximately six to seven days. The mature Aedes mosquito breeds, feeds, and dies within a week or two, which is the life cycle of most mosquitoes.

### 2.1.1.2 THE ANOPHELES MOSQUITO:

The Anopheles is different from other types of mosquitoes as it is the genus most accountable for spreading malaria to humans. Malaria can be fatal; its typical symptoms include fever, headaches, chills, and general flu symptoms. The species of Anopheles known as Gambiae is infamous for transmitting plasmodium falciparum, the most threatening form of malaria in the world.

The Anopheles mosquito is generally located near bodies of water, such as ponds, swamps, marches, ditches, and rain pools. The Anopheles female favors laying its eggs in fairly still water that is oxygenated, and where there is an abundance of wild plant life. Some species enjoy the shady areas, while others prefer sunlight.

### 2.1.1.3 THE CULEX MOSQUITO:

The genus of mosquito known as the Culex can be considered the least dangerous of the three major types of mosquitoes due to the fact that humans are not their preferred blood meal. Instead, most species of Culex are partial to biting birds rather than humans. Despite this inclination, the Culex female mosquito is nevertheless recognized as spreading diseases such as the West Nile virus, malaria, filariasis, and encephalitis.

The Culex, like the Anopheles, tends to favor standing water to lay its eggs; however, unlike the Anopheles, it does not necessarily opt for plant and wild life surroundings. Instead, it often breeds in the outdoor objects on your property, such as barrels, cans, garden pots, used tires, as well as other places where stagnant water can collect

Each of the species has a scientific name that is latin, such as Culex tarsalis. These names are used in a descriptive manner so that the name tells something about this particular mosquito. Some species have what is called "common names" as well as scientific names, such as Anopheles freeborni, the "Western malaria mosquito".

| SEVERAL KINDS OF PEST MOSQUITOES | | | | |
|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Breeds In** | **Flight Distance** | **Diseases or Other** |
| *Aedes aegypti* (Linnaeus) | yellow fever mosquito | clean water | 1 - 5 miles | yellow fever, canine heartworm dengue, encephalitis |
| *Aedes albopictus* (Skuse) | Asian tiger or forest day mosquito | tires, artificial container | 1 - 5 miles | dengue |
| *Aedes dorsalis* (Meigen) | salt marsh mosquito | fresh or brackish water, moist soil | 1 - 30 miles | encephalitis |
| *Aedes nigromaculis* (Ludlow) | —— | muddy pastures | 2 - 5 miles | encephalitis |
| *Aedes sierrensis* (Ludlow) | tree hole mosquito | tree holes, tires, containers | ½ mile | canine heartworm |
| *Aedes sollicitans* (Walker) | salt marsh mosquito | brackish marshes and saline areas | 5 - 20 miles | —— |
| *Aedes squamiger* (Coquillette) | California salt marsh mosquito | salt marsh, rain water filled depressions | 5 - 20 miles | aggressive biter, encephalitis |
| *Aedes taeniorhynchus* (Wiedi) | black salt marsh mosquito | salt marsh, flats flooded by high tides | 5 - 20 miles | aggressive biter, encephalitis |
| *Aedes vexans* (Meigen) | swamp mosquito | temporary pools | 5 - 20 miles | aggressive biter, canine heartworm |
| *Aedes washinoi* (Washino) | woodland pond mosquito | woodland depressions, pools , mud holes | —— | aggressive biter, unknown |
| *Anopheles freeborni(Aitken)* | Western malaria mosquito | fresh water, rice fields | 1 - 10 miles | malaria |
| *Anopheles quadrimaculatus* (Say) | common malaria mosquito | permanent fresh water | 1 - 2 miles | malaria, canine heartworm |
| *Culex pipiens* (Linnaeus) | Northern house mosquito | foul water, containers, ditches, etc. | 1 mile | West Nile, encephalitis, canine heartworm |
| *Culex tarsalis* (Coquillette) | encephalitis mosquito | stagnant water with vegetation | 2 - 10 miles | West Nile, encephalitis |
| *Culiseta incidens* (Thomson) | cool weather or fish pond mosquito | creeks, ponds, containers, etc. | ½ mile | large bites at sunset, heartworm |
| *Culiseta inomata* (Williston) | winter marsh mosquito | rain filled ponds, man made sources | ½ mile | large bites at sunset |
| *Sources: Service 1980, Almeda 1999, Olkowski et al . 1991, etc.* | | | | |

## 2.1.2 ATTRACTION OF MOSQUITOES TOWARDS HUMAN BEINGS:

Although researchers have yet to pinpoint what mosquitoes consider an ideal hunk of human flesh, the hunt is on. "There's a tremendous amount of research being conducted on what compounds and odors people exude that might be attractive to mosquitoes," says Joe Conlon, PhD, technical advisor to the American Mosquito Control Association. With 400 different compounds to examine, it's an extremely laborious process. "Researchers are just beginning to scratch the surface".

Scientists do know that genetics account for a whopping 85% of our susceptibility to mosquito bites. They've also identified certain elements of our body chemistry that, when found in excess on the skin's surface, make mosquitoes swarm closer. "People with high concentrations of steroids or cholesterol on their skin surface attract mosquitoes," Butler tells WebMD. That doesn't necessarily mean that mosquitoes prey on people with higher overall levels of cholesterol, Butler explains.

These people simply may be more efficient at processing cholesterol, the byproducts of which remain on the skin's surface.

Mosquitoes also target people who produce excess amounts of certain acids, such as uric acid, explains entomologist John Edman, PhD, spokesman for the Entomological Society of America. These substances can trigger mosquitoes' sense of smell, luring them to land on unsuspecting victims. But the process of attraction begins long before the landing. Mosquitoes can smell their dinner from an impressive distance of up to 50 meters, explains Edman. This doesn't bode well for people who emit large quantities of carbon dioxide.

"Any type of carbon dioxide is attractive, even over a long distance," Conlon says. Larger people tend to give off more carbon dioxide, which is why mosquitoes typically prefer munching on adults to small children. Pregnant women are also at increased risk, as they produce a greater-than-normal amount of exhaled carbon dioxide. Movement and heat also attract mosquitoes.[3]

### 2.1.3 MOSQUITO CONTROL:

Methods used to prevent the spread of disease, or to protect individuals in areas where disease is endemic, include:

- Prevention of mosquito bite with mosquito repellent textile.
- Vector control aimed at mosquito control or eradication.
- Disease prevention, using prophylactic drugs and developing vaccines.
- Prevention of mosquito bites, with insecticides, nets and repellents.

Since most such diseases are carried by "elderly" female mosquitoes, some scientists have suggested focusing on these to avoid the evolution of resistance.

Elephantiasis or Lymphatic Filariasis is an infection of parasitic roundworms like: Wuchereria Bancrofti, Brugia Malayi, and Brugia Timori. Elephantiasis currently affects 20 million people worldwide. When an infected mosquito bites a person the mosquito can inject the parasitic roundworms into the bloodstream and travels to your lymph system. The worms may live undetected for years, and then symptoms of Elephantiasis may surface, such as: lymphedema (extremely enlarged/swollen) of the arms, legs, genitalia, and breasts. This enlargement of extremities occurs when the parasites cause blockages in the blood vessels and fluid builds up. Additional bacterial infections and decreased immune function can also result from the infestation in the lymph system.

### 2.1.3.1 HOUSEKEEPING & MAINTENANCE:

1. Remove all sources of stagnant or standing water if possible, e.g., old tires, bird baths, cans, trash barrels, wading pools, etc., or add Safe Solutions, Inc. Enzyme Cleaners, at a rate of a few drops per gallon of water. Don't forget to fill in any low areas that hold water for more than 7 days.

2. Spray the area and drains with Safe Solutions, Inc. #2 Enzyme Cleaner (4 oz. per qt. water) or Safe Solutions, Inc. Enzyme Cleaner with Peppermint (1 oz. per qt. water) or Not Nice to Bugs® (2 oz. per qt. water). Remove or spray bushes and dense shrubbery and vines by doors and patios with hose-end sprayers and enzyme cleaners. Adding xanthan gum to water kills mosquito larvae.

3. Turn on fans to "blow them away." (Note: A misting fan works best.) Sit in the breeze (even if it is from a fan). They will not bother you.

4. Mosquito bite relief: Soak bites in Epsom salt water or apply a paste of salt or protease enzymes mixed into lard or cold cream. Not Nice to Irritations and bentonite clay also help relieve bites and stings.

5. Spraying diluted Safe Solutions, Inc. #2 Enzyme Cleaner (3 oz. - 5 oz. per gal. water) or Safe Solutions Enzyme Cleaner with Peppermint (1 oz. per gal. water) or garlic oil or liquid garlic will control mosquitoes immediately. Garlic, cedar, peppermint or lemon oils or citrus-based sprays also kill mosquitoes and other insects. Safe Solutions Insect Repellent works well as a safe repellent.

6. Rub 4% citronella oil into 96% Vaseline, cedarwood, lavender or soybean oil or scented geraniums on clothing and/or exposed areas or burn citronella candles. CNN 8/28/01: Iowa State says catnip is 10x more effect than DEET. Lemongrass, clove oil, basil, oils of avocado, birch, mint, thyme, pine, rosemary, spearmint and/or yarrow all repel mosquitoes. Be sure you are not sensitive.

7. Solutions of aspirin or Ben Gay or bisabolene or pennyroyal, rubbed on the skin (if you are not sensitive), tansy or scented geraniums planted near a door, or basil plants will repel mosquitoes. Myrrh burned as incense will also repel mosquitoes. Wear protective clothing or put geraniol or geranium oil, catnip or Noxema, soybean oil or vinegar on the skin if you are not sensitive. Caution:

If you are pregnant, don't use pennyroyal, even topically, as it may increase the risk of miscarriage. Note: Citronella oil has been known to attract female black bears.

8. Practice proper exclusion; repair 16 to 18 mesh screens; seal windows and doors and caulk.

9. Lightly dust the surface of the water with Safe Solutions, Inc. food grade diatomaceous earth or powdered starch.

10. Caution - Test anything you want to put on your skin on a small area first.

11. Some people are more attractive to mosquitoes than others. Mosquitoes are attracted to dark clothing, carbon dioxide and sweat. Prime feeding times are late dusk and early evening. Some people react more seriously to mosquito saliva, the chemical that causes the bites to swell and itch. Carry a small "spritzer" bottle filled with diluted Safe Solutions, Inc. enzyme cleaner, apply and rub into to bite area - this will reduce the swelling and itching.

12. Turpentine and eucalyptus oils, garlic extracts, surface oils, extracts of orange and lemon peel will all control mosquito larvae as will water treated with 15% borax, but be careful not to pollute potable water!

13. If you still are seeing mosquitoes, read the entire chapter.

### 2.1.3.2 CHEMICAL MOSQUITO REPELLENTS:

DEET is an acronym for the long technical name: N, N-diethyl-meta-toluamide. Developed in 1946, DEET has been used extensively since then and serves as the standard mosquito repellent against which new candidate materials are tested. In addition to working on mosquitoes, it works well on fleas, biting midges (punkies, no-see-ums) and black flies. It doesn't work well on snipe flies, deer flies, greenheads or horse flies. (By the way, no repellents really work on those groups.) Ticks and chiggers are closely related to mosquitos, and DEET workson them, too. Repellents that have higher concentrations of DEET generally last longer and are more effective (to a point) than those with low concentrations. DEET should never be allowed into mucous membranes (nose, mouth, eyes), and should never be used on infants less than two months old. Officials don't

recommend using products containing more than 30 percent DEET. A few people are allergic to it. DEET is greasy and also dissolves some plastics and finishes.

### 2.1.3.3 PICARIDIN:

Picaridin is a relatively new repellent. It first became available in U.S. products in 2005. For most species, it's as effective as DEET, but appears to lack some of DEET's shortcomings. It doesn't dissolve plastics or finishes, and no allergic reactions have been noted. Perhaps as products containing picaridin become more widely used, some shortcomings might appear. Picaridin works well on mosquitoes, and also biting midges (punkies/no-see-ums) and chiggers. It works almost as well as DEET on ticks. N.H.-registered repellents with low picaridin concentration are labeled for mosquitoes, biting flies and chiggers. Those with higher concentrations include ticks on the label. Avon, Cutter, Go Ready, Natrapel, OFF, Repel, Sawyer and Walgreens are brand names that include picaridin repellents registered in New Hampshire.

### 2.1.3.4 CITRONELLA:

Citronella is a natural product with limited repellence to mosquitoes. It is incorporated in some candles and torches, in addition to repellents. The material is derived from two grasses native to tropical Asia: Cymbopogon nardus (L.)Rendle ("mana grass") and C. winterianus Jowitt.

### 2.1.3.5 2-UNDECANONE:

2-Undecanone is a chemical derived from wild tomato plants. Some chemical registries refer to the same compound as methyl nonyl ketone. In preliminary tests on American dog ticks and some mosquitoes, it worked as well as or better than DEET. EPA registered the material as an mosquito repellent in 2007. As this is written (February 2009), it isn't yet available in New Hampshire. BioUD is a trade name for products with this active ingredient. A search of the N.H. pesticide registry uncovered a surprise: we have many products with this chemical, registered to repel or train dogs & cats, but not formulated for use as mosquito repellents.

### 2.1.3.6 IR3535 (ETHYL BUTYL ACETYL AMINOPROPRIONATE):

IR3535 (ethyl butyl acetyl aminoproprionate) has several chemical names. The chemical was designed in the early 1970s and has been available in Europe since the mid-1970s. Tests show that it works moderately well on mosquitoes and fairly well on blacklegged tick. At least three manufacturers (Sawyer, Chattem, and Avon) make products that combine sunblock and mosquito repellent, contain this chemical, and are registered for use in NH. The Chattem ("Bullfrog Mosquito Coast") and Sawyer products typically have 20 percent IR3535 and are registered for mosquitoes. The Avon products have lower percentage of active ingredients and are registered for "biting midges, black flies, deer ticks, gnats, mosquitoes, no-see-ums, and sandflies."

### 2.1.3.7 OTHER REPELLENTS:

Other repellents Research continues to turn up new candidates for registration as repellents. Recent examples include A13-37220 and tansy essential oil. Perhaps these will eventually appear in commercial mosquito or tick repellents. Amitraz and permethrin are two artificial chemical pesticides for ticks that show what is sometimes called repellency. Rather than being true repellents, they seem to create irritation and toxicity symptoms in ticks, which cause ticks to drop off and prevent them from attaching. Tick control products containing fipronil can also prevent tick attachment, which some people interpret as "repellency." Dimethyl phthalate, R-11 and ethyl hexane diol were fairly effective against mosquitoes and black flies, but they are no longer available in repellents. They were discontinued in the early 1990s, based on health concerns. [4]

## 2.1.4 EFFECTS MOSQUITO REPELLENT CHEMICALS ON HEALTH:

As a precaution, manufacturers advise that DEET products should not be used under clothing or on damaged skin, and that preparations be washed off after they are no longer needed or between applications. DEET can act as an irritant in rare cases, it may cause skin reactions.

In the DEET Reregistration Eligibility Decision (RED), the United States Environmental Protection Agency (EPA) reported 14 to 46 cases of potential DEET-associated seizures, including 4 deaths. The EPA states: " it does appear that some cases are likely related to DEET toxicity," but observed that with 30% of the US population using DEET, the likely seizure rate is only about one per 100 million users.

The Pesticide Information Project of Cooperative Extension Offices of Cornell University states that "Everglades National Park employees having extensive DEET exposure were more likely to have insomnia, mood disturbances and impaired cognitive function than were lesser exposed co-workers".

When used as directed, products containing between 10% to 30% DEET have been found by The American Academy of Pediatrics to be safe to use on children as well as adults but recommends that DEET not be used on infants less than two months old.

Citing human health reasons, Health Canada barred the sale of insect repellents for human use that contained more than 30% DEET in a 2002 re-evaluation. The agency recommended that DEET based products be used on children between the ages of 2 and 12 only if the concentration of DEET is 10% or less and that repellents be applied no more than 3 times a day, children under 2 should not receive more than 1 application of repellent in a day and DEET based products of any concentration not be used on infants under 6 months.

Recently, DEET has been found to inhibit the activity of a central nervous system enzyme, acetylcholinesterase, in both insects and mammals.This enzyme is involved in the hydrolysis of the neurotransmitter acetylcholine, thus playing a role in the function of the neurons which control muscles. Because of this property, many insecticides are used to block acetylcholinesterase, which leads to an excessive accumulation of acetylcholine at the synaptic cleft, causing neuromuscular paralysis and death by asphyxiation.DEET is commonly used in combination with insecticides and has the capacity to strengthen the toxicity of carbamates, a class of insecticides known to block acetylcholinesterase. These findings bring evidence that, besides having known toxic effects on the olfactory system, DEET also acts on the brain of insects, and that its toxicity is strengthened in combination with other insecticides. It has long been known that the most effective insect repellents are those that contain a high percentage of DEET as their active ingredient. DEET is a well known abbreviation for the chemical N,N-diethyl-meta-toluamide. DEET has been marketed commercially since 1956 and is used by an estimated 50-100 million persons each year. Repellents containing DEET are formulated as aerosols, lotions, creams, soaps, and semisolid sticks. In general, the inexpensive, over-the-counter repellents contain less than 10% DEET, while the more expensive formulations are at least 20% DEET. The repellent formulation used by the U.S. Army is 75% DEET in an ethanol carrier. Formulations containing from 50% to 75% DEET can be purchased

through camping stores. Repellents are usually applied to the skin, especially on the arms, legs, neck, and face. Sometimes, the repellent is applied directly to clothing. One company has marketed a mesh sweatshirt designed to be stored in a 90% formulation of liquid DEET and then used for outdoor activity in areas where biting flies are abundant. DEET is sometimes applied to bed nets to protect humans in areas where arthropod-borne diseases are common. In some areas, liquid repellents are sprayed on pets, especially dogs and horses, to help protect them against biting flies and the diseases they carry.

Repellent use is generally directed against mosquitoes. However, DEET containing repellents also are quite effective at protecting against the bites of black flies, sand flies, horse flies, deer flies, and chiggers. Recently, because of the growing concern over Lyme disease throughout the eastern and Midwestern United States, some companies have repackaged and re-advertised their repellents. Many well-known repellents are now prominently advertised as being effective against ticks. DEET remains the active ingredient in all of these repellents. Because of the Lyme disease scare, repellents are now used much more frequently, especially on small children. This is because ticks are abundant throughout the warm season and are active throughout the daylight hours. On the other hand, mosquitoes and other biting flies tend to be more periodic in their seasonal distribution and their daily activity is more restricted. An impressive amount of scientific evidence collected over the past few years has demonstrated that repellents can help to protect individuals against arthropod-borne diseases in areas of the world where these diseases present a human health risk. There has been some concern that over-application of DEET may have toxic side effects. A 1987 report in the Journal of the American Medical Association documented five cases of severe toxic reaction and death following the ingestion of DEET-containing insect repellent. Of more immediate concern is the fear that toxic side effects may be associated with DEET absorbed through the skin. Workers in the field who rely on DEET-containingrepellent for protection against biting flies may be exposed to nearly 900 grams of DEET a year. Human studies have shown that 9 to 56% of topically applied DEET can penetrate the skin and up to 17% can be absorbed into the circulatory system. Skin irritation resulting from DEET application is frequently reported. These side effects seem to be particularly acute when infants and children are involved.

In October 1989, the Centers for Disease Control (CDC) in Atlanta, Georgia reported five cases of seizures associated with the use of DEET insect repellent. Three of the cases were from

New York and two from Connecticut. Four of the patients were boys aged 3-7 years and one was a 29-year-old man. The onset of seizures ranged from 8-48 hours after the application of repellent. All of the afflicted individuals recovered quickly. As a result of these cases, health officials in New York, Connecticut, and New Jersey issued a health alert advising caution in the use of DEET-containing repellents. At the same time, health officials reinforced the importance of DEET for protection against Lyme disease.[5]

### 2.1.5 MOSQUITO REPELLENT PRODUCTS:

#### 2.1.5.1 REPELLENT BAR:

This is a recently developed inexpensive personal repellent that provides relatively long-lasting protection. It is made of materials used in soap production, such as coconut oil, and contains 20% deet and 0.5% permethrin. The bar is used by wetting it (or the skin) and producing a lather that is rubbed on exposed parts of the body (Fig. 1.40). The face can be protected by application to the neck, forehead and ears. After application a white lotion-like film remains on the skin for a short time. The residual film feels sticky and some users find it unpleasant. It is not easily removed by contact with clothes but can be removed by rinsing or rubbing. The method is considered safe but care should be taken to avoid sensitive skin areas when it is used on small children. However, it is not yet recommended by WHO for long periods of repeated daily usage, pending a full safety evaluation. The repellent bar should be applied at sunset to provide protection during the evening. Depending on the local mosquito species and other factors, the repellent soap protects for 4–8 hours. Under optimal conditions, protection lasting up to 12 hours may be achieved. The amount and duration of protection have been reported to vary for different species of insects and different conditions of use.

A 40-gram bar, used daily and sparingly on arms, legs and other exposed areas, lasts approximately 20 days. Although the bar is patented, the patent holder permits local production for noncommercial purposes. The procedure and ingredients are similar to those for the production of soap.

### 2.1.5.2 INSECT-REPELLENT WIDE-MESH NETTING JACKETS:

Special jackets made of wide-mesh netting, with a hood to protect the head, may provide sufficient protection from biting insects when impregnated with deet or other. They are especially suitable for people on brief visits to areas infested with high densities of mosquitos and other biting insects, as in northern Siberia, Scandinavia and Alaska. Open-mesh material offers the advantages that it can be used in combination with normal clothing or with no clothing beneath and that it is relatively cool. A disadvantage is that the netting easily gets entangled in dense vegetation; it is most practical in areas with little vegetation. The jackets can be made of strong wide-mesh cotton or a mixture of polyester/cotton or nylon. Mesh jackets sold in Canada and the USA are made of polyester netting containing strands of cotton. Cotton is required to absorb the desired treatment level of 0.25 g of DEET per gram of netting (or 10–15 g of deet per m2). The jackets should be stored in an airtight plastic bag when not in use.

### 2.1.5.3 INSECT-REPELLENT HEADNETS:

Wide-mesh netting similar to that used in the jackets described above can be employed to protect the head and neck. It is preferably used in combination with a hat or other head covering. The netting allows good visibility and ventilation.

### 2.1.5.4 INSECT-REPELLENT BANDS AND ANKLETS:

Many species of bloodsucking insects bite predominantly around the ankles and wrists. Strips of cotton fitted around the extremities and impregnated with a repellent reduce biting substantially The cotton strips are about 10 cm wide and 35 cm long and can be provided with buttons and buttonholes or can be elasticized (like sweat bands) so that they remain in place. The bands are used with a repellent rather than an insecticide because repellent vapour action protects nearby uncovered areas of the body. When not in use, the anklets should be stored in an airtight plastic bag or tin to reduce evaporation of the repellent. The recommended dosage of deet concentrate (95%) for one band is 4 ml, or the band may be saturated in a 30% deet/alcohol mixture. If used for about 2 hours each evening, deet-impregnated bands remain effective for at least 50 days.

### 2.1.5.5 INSECTICIDE VAPORIZERS:

Unlike repellents, only a few insecticides, such as dichlorvos, have a spatial effect at normal room temperature. However, some insecticides kill or repel insects at a distance through an airborne effect when vaporized with a heating device. Insecticides can also be released into the air as aerosols, for example when sprayed from pressurized spray cans. Dispensers releasing insecticide into the air help to protect people nearby. Traditionally, plants or wood containing repellent or insecticidal substances have been burned (*23*, *60*). More modern devices include mosquito coils, vaporizing mats, dichlorvos dispensers and aerosol spray cans; these are relatively inexpensive and may protect several people at a time. However, their use is confined to houses and other places with limited ventilation. They may be effective in dense vegetation
where the repellent is not too diluted by air movements. The compounds used are mostly quick-acting knockdown insecticides with both a killing and a repellent effect, for instance the allethrins, a group of pyrethroid insecticides. The allethrins are considered to be safe to humans if used properly. Insecticide vaporizers protect against mosquitos and biting flies by:

— preventing them from entering a room (deterrent effect);

— irritating and disturbing them after contact (excito-repellent effect) and preventing them from biting;

— paralysing or killing them (insecticidal effect). smoulder at a steady rate for 6–8 hours, steadily releasing insecticide into the air.

Originally, mosquito coils consisted of a mixture of pyrethrum powder (see box), a combustible filling material, such as sawdust, and a binder, such as starch. Some of the synthetic pyrethroids, especially knockdown agents like the allethrins, are now commonly used in coils. They are more effective and more easily obtainable than pyrethrum (*61*). DDT is an ingredient of some brands of coil in China but is ineffective when used in this way (*61*). To make the smoke more acceptable the coil sometimes incorporates a fragrance. The shelf-life of coils is at least three years if they are packed in paper or plastic and stored in boxes, protected from light
and moisture.

### 2.1.5.6 REPELLENT ROPES:

A cheaper alternative to mosquito coils has been developed in India (68): ropes soaked in a solution of a suitable insecticide, when burnt, produce a smoke that kills and repels mosquitos and biting flies. The recommended material, widely available in India, consists of jute fibres, is about

0.9cm in diameter and weighs about 28g/m. Esbiothrin was used in India, but other insecticides used in mosquito coils would also be suitable. A 1.2-m impregnated rope will burn for 10–12 hours if hung indoors from a ceiling. The ropes are preferably burned inside cylinders of wire mesh to prevent them from making contact with flammable materials.

### 2.1.5.7 ELECTRIC LIQUID VAPORIZER:

This device is a technological improvement on vaporizing mats. The insecticide is evaporated by an electric heater through a porous wick from a reservoir bottle containing the liquid (Fig. 1.49). The liquid insecticide lasts for up to 45 periods of 8–10 hours. Many models are controlled by a switch and have a pilot lamp. This method is more convenient and more effective than the mat heater because the amount of insecticide released remains constant over time, but for the moment it is more expensive.

### 2.1.5.8 DICHLORVOS DISPENSER:

Dichlorvos is a volatile liquid whose vapour is highly toxic to flying insects. Liquid dichlorvos impregnated into a special absorbent material, such as polyurethane, slowly evaporates without the need for a heating device. A dispenser usually consists of a piece of polyvinyl chloride plastic or a resin saturated with liquid dichlorvos, mounted in an open plastic support (Fig. 1.50). Some dispensers are strips measuring 5 × 25 cm, while others have the shape of a small box. They are sealed in an airtight package to avoid premature vaporization of the insecticide. The dispenser in its plastic support is placed at a height of 1–2 m above the floor or is suspended from the ceiling. Most models contain sufficient dichlorvos to treat a room of 15–30 m3 for 1–2 months. A strong draught will shorten the period of effectiveness. The advantages of this method are the long period of effectiveness and the lack of a need for electricity, making it especially suitable for use in rural houses, tents or caravans. The continuous exposure of young children and sick or elderly people to dichlorvos in poorly ventilated rooms should be avoided. Some reports suggest that continuous exposure to dichlorvos may have caused health problems in a few people.

### 2.1.5.9 PRESSURIZED SPRAY CANS:

Pressurized cans provide a convenient method of spraying insecticidal aerosols in rooms, on mosquito nets, vehicles and so on, to obtain rapid knock-down of mosquitos and other flying insects. The spray cans contain a concentrate of the insecticide in an organic solvent or water together with a

liquefied or compressed gas propellant. Pyrethrum used to be the common ingredient in many different brands of aerosol sprays. Today, however, the synthetic pyrethroids and to a lesser extent the carbamates (propoxur and bendiocarb) and organophosphorus compounds (dichlorvos) are the main active ingredients. The spray may contain a "knock-down" agent to give a rapid effect, a slow-acting agent that actually kills the insect, and a synergist—usually piperonyl butoxide—to increase the activity of the ingredients. In view of worldwide concern about the use of chlorofluorocarbons, which may affect the ozone layer of the atmosphere, most brands now contain other propellants. The spray can is operated by briefly pressing a valve incorporating a nozzle on top of the container. The spray can be directed against flying or crawling insects or sprayed into a room. Rooms should then be kept closed for about 15 minutes in order to kill as many insects as possible. The hiding and breeding places

of cockroaches, fleas, lice and bedbugs can be sprayed directly from a distance of about 20 cm.

Space sprays have a very short residual effect: once the aerosol has settled out of the atmosphere insects can again enter the area with impunity. Furthermore, the active ingredients (commonly (+)-allethrin or (+)-*trans*-allethrin) are rapidly degraded by light. An advantage of short-lasting insecticides is that they do not leave any toxic residues on beds, furniture or other surfaces. This method works best in screened spaces and can be repeated daily or several times a day. The spray can is under pressure and should not be exposed to direct sunshine or temperatures over 50 °C. Most sprays contain the flammable substances propane or butane and should not be directed at fires or smouldering objects, e.g. cigarettes.

### 2.1.5.10 WATER-BASED AEROSOL SPRAY:

Water-based aerosol sprays have recently been developed and are claimed to offer the following advantages over oil-based aerosols: they leave no oil residues or stains on surfaces, do not produce an unpleasant smell or an irritant effect, and are not flammable. However, the droplets of oil-based aerosols are usually finer and more effective. The cans must be shaken well before use.

### 2.1.5.11 ELECTRONIC BUZZERS:

Battery-operated electronic devices that produce a high-pitched buzz have been widely sold as mosquito repellents. Some manufacturers have claimed that they simulate the sound of a male mosquito and that this sound is repellent to mated females. Others claimed that the buzzers simulate the sound of the dragonfly, thus inducing mosquitos to fly away. However, several independent

scientific investigations in different countries have convincingly demonstrated that these electronic gadgets provide no protection from biting mosquitos. An apparently positive test by producers was faulty in design. In the United Kingdom some companies have been fined for making unsubstantiated claims in their advertisements for buzzers.

### 2.1.5.12 SCREENING MATERIALS:

Cotton netting: efficient but easily damaged; ventilation is reduced by up to 70%.
Metal screens: ventilation is reduced by 30–50%; rodents are prevented from entering. Many metals corrode rapidly in humid areas; stainless steel or copper screens avoid this problem but are expensive.

**Plastic sereens:** cheap and easily fitted; ventilation is reduced by up to 35%. Nylon screening is not durable when exposed to direct sunlight; fibreglass coated in PVC is more durable.

### 2.1.5.13 PROTECTIVE CLOTHING:

Clothing can offer protection from biting insects when it is of a thickness and texture through which insects cannot easily bite. Lighter colours generally attract fewer insects than darker colours. Boots can protect the ankles from biting insects. Thick socks in combination with long trousers offer protection when the bottoms of the trousers are tucked into the socks. Some protection is also offered by longsleeved shirts, headnets, collars and hats. However, some insects can bite through socks or other clothes; the treatment of clothing with an insecticide or repellent can deter this. The small biting midges, sandflies and blackflies are unable to bite through clothes, even if these are made of thin material. People active during daytime can best protect themselves by wearing thin clothing over as much of the body as possible and applying repellents to the parts of the body left exposed. Repellents are only partially effective against swarms of biting midges. Headnets or hooded wide-mesh jaekets impregnated with a repellent offer good protection.

### 2.1.5.14 TREATED CLOTHING:

Clothing can be treated with repellents to prevent insects from landing or feeding, or with quick-acting insecticides of the pyrethroid group, such as permethrin. These latter compounds do not repel the insects but allow them to make contact with the fabric and irritate or kill them before they manage to feed. The application of repellents to clothing and other fabrics is preferable to skin application beeause it reduces the likelihood of allergic reactions. Limited contact with the human

skin and strong adherence to fabric fibres make it possible to use higher doses of repellents and insecticides. Synthetic pyrethroid insecticides are generally preferred to volatile repellents for treating clothing because:

— They act quickly and repel or kill biting insects;

— They are long-lasting and to some extent withstand weathering, sunlight and washing in cold water;

— They are more pleasant to use (little or no odour, colour or greasiness);

— They are safe and do not irritate human skin if applied at the correct doses.

— They do not affect plastic products;

— They are cheaper than repellents, only infrequent applications of small amounts being required.

However, if the clothing is treated with a non-repellent pyrethroid, flying insects may feed on uncovered skin, necessitating the application of a repellent to the bare skin. Because of the vapour effect, clothing freshly treated with a volatile repellent offers more protection to uncovered skin than that treated with a pyrethroid insecticide. Impregnated socks can give effective protection against blackflies, which often bite around the ankles. Impregnated trousers and stockings provide effective protection from ticks and mites. Treated clothing is also effective against mosquitos, sandflies, biting midges, fleas and body lice. Repellents may remain effective for up to a week when applied to clothing. An extended efficacy can be obtained by sealing the impregnated fabric in a container or airtight bag when not in use to prevent evaporation of the repellent. A repellent applied to clothing normally retains its effect longer than on skin because there is:

- no loss by abrasion;
- no loss due to skin absorption;
- no removal of the active compound by sweating;
- slower evaporation because of lower temperature, except when clothing is exposed to sunlight;
- better adherence to cotton and synthetic fibres.

Clothing treated with permethrin can remain toxic to insects and ticks for several weeks or months, depending on wear and exposure to washing and rain. Treated clothing may remain effective after up to 10 rinses with cold water and soap. However, more permethrin is lost after washing in hot water and soap.

## 2.2 MICRO-ORGANISMS:

The microorganism term is used instead of microbes; they are very small organisms size belonging to various groups: Bacteria, Fungi, Protozoa, one can add Viruses, characterized by their noncellular structure. Microorganisms were observed for the first time in 1674 by Van Leeuwenhoek but they are only identified 200 years later. Although those organisms are incredibly small (their size ranges from 0.03 µm for the virus of the foot-and-mouth disease to 300 µm for Paramecium), they play a significant role to keep the planet running. Indeed, they carry out 90% of the biochemical reactions produced on earth, without them the life on earth would be destroyed.

The micro-organisms are probably the first alive beings appeared on ground, they would be thus the common ancestors of all the living being. Although microorganisms appeared 3.8 billion years ago, they are observed by Pasteur and koch through their microscope way after their apparition. Pasteurdelivered the fatal blow to the doctrine of spontaneous generation thanks to his examination and Koch discovered revealed the existence of bacilla at the origin of tuberculosis. Those discoveries ehanged radically the perception of the human beings on the world.[6]

### 2.2.1 TYPES OF MICRO ORGANISMS:

The are 4 types of micro organisms. It includes

1. Bacteria
2. Fungi
3. Virus
4. Algae

### 2.2.2 BACTERIA:

Bacteria are organisms made up of just one cell. They are capable of multiplying by themselves, as they have the power to divide. Their shapes vary, and doctors use these characteristics to separate them into groups.

Bacteria are a large domain of prokaryotic microorganisms. Typically a few micrometers in length, bacteria have a wide range of shapes, ranging from spheres to rods and spirals. Bacteria are present in most habitats on Earth, growing in soil, acidic hot springs, radioactive waste,[2] water, and

deep in the Earth's crust, as well as in organic matter and the live bodies of plants and animals, providing outstanding examples of mutualism in the digestive tracts of humans, termites and cockroaches. There are typically 40 million bacterial cells in a gram of soil and a million bacterial cells in a milliliter of fresh water; in all, there are approximately five nonillion ($5\times10^{30}$) bacteria on Earth, forming a biomass that exceeds that of all plants and animals.[4] Bacteria are vital in recycling nutrients, with many steps in nutrient cycles depending on these organisms, such as the fixation of nitrogen from the atmosphere and putrefaction. In the biological communities surrounding hydrothermal vents and cold seeps, bacteria provide the nutrients needed to sustain life by converting dissolved compounds such as hydrogen sulphide and methane. Most bacteria have not been characterized, and only about half of the phyla of bacteria have species that can be grown in the laboratory. Bacteria exist everywhere, inside and on our bodies. Most of them are completely harmless and some of them are very useful. But some bacteria can cause diseases, either because they end up in the wrong place in the body or simply because they are 'designed' to invade us.[7]

### 2.2.2.1 TYPES OF BACTERIA:

1. Gram positive bacteria
2. Gram negative bacteria

### 2.2.2.2 STAPHYLOCOCCUS AUREUS:

Staphylococcus aureus is the most common cause of staph infections. It is a spherical bacterium, frequently part of the skin flora found in the nose and on skin. About 20% of the population is long-term carriers of "S. aureus". "S. aureus" can cause a range of illnesses from minor skin infections, such as pimples, impetigo (may also be caused by "Streptococcus pyogenes"), boils (furuncles), cellulitis folliculitis, carbuncles, scalded skin syndrome and abscesses, to life-threatening diseases such as pneumonia, meningitis, osteomyelitis, endocarditis, toxic shock syndrome (TSS), bacteremia and septicemia.

Its incidence is from skin, soft tissue, respiratory, bone, joint, endovascular to wound infections. It is still one of the five most common causes of nosocomial infections, often causing postsurgical wound infections. Abbreviated to "S. aureus" or "Staph aureus" in medical literature, "S. aureus" should not be confused with the similarly named and similarly dangerous (and also medically relevant) species of the genus "Streptococcus".

"S. aureus" was discovered in Aberdeen, Scotland in 1880 by the surgeon Sir Alexander Ogston in pus from surgical abscesses. Each year some 500,000 patients in American hospitals contract a staphylococcal infection.

### 2.2.2.3 ESCHERICHIA COLI:

Escherichia coli, also known as E. coli is a bacterium that is commonly found in the gut of endotherms (warm blooded organisms). Several types of E. coli exist as part of the normal flora of the human gut and have several beneficial functions, such as the production of vitamin K2. They also prevent harmful bacteria, known as pathogenic bacteria, from establishing themselves in the intestine. Most E. coli strains pose no harm to human health, except for serotype O157:H7, which can cause food poisoning in humans and can become life-threatening. Other less common serotypes, such as O104:H4, O121, O26, O103, O111, O145,and O104:H21 can also cause serious infection.[8]

### 2.2.3 REQUIREMENTS FOR ANTIBACTERIAL FINISH:

Textile materials, in particular the garments are more susceptible to wear and tear. It is important to take into account the impact of stress strain, thermal and mechanical effects on the finished substrates. The following requirements need to be satisfied to obtain maximum benefits out of the finish:

1. Durability to washing, dry-cleaning and hot pressing.
2. Selective activity to undesirable micro organisms.
3. Should not produce harmful effects to the manufacturer, user and the environment.
4. Should comply with the statutory requirements of regulating agencies.
5. Compatibility with the chemical processes.
6. Easy method of application. No deterioration of fabric quality.
7. Resistant to body fluids; and resistant to disinfections/sterilisation.

### 2.2.4 ADVANTAGES OF ANTI BACTERIAL TEXTILES:

- It inhibits the growth of odor causing and numerous other bacteria and fungi.
- It lasts wash after wash for the life of the product.
- It creates a zone of inhibition beyond the surface of the fiber.

## 2.3 HERBS:

An herb is defined as a botanic material known before history used by native people for their food and/or medicine. In all regions of the world, we owe native people our gratitude for the knowledge handed down to the people of recorded history. For example, where would the British be without the herbal medicine and food plants of their Native Indians – The Scots, Irish, Celts, Picts, Faerie folk. FYI, The natives wore leathers, painted their bodies like Native Americans. They gave the world a grand resource of herbs used in natural medicine today. To mention a few- angelica, garlic, chrysanthemum, hawthorn, digitalis, licorice root, holly, seaweed, many varieties of mushrooms, etc. The past shamans or medicine men and women of all cultures have preserved a rich plant knowledge which many patients are the beneficiary in natural medicine clinics, daily. Any master herbalist appreciates this fact, but in reality, this fact is quickly disappearing. With civilization growing and not reversing, many species are becoming extinct. Many undiscovered flora are being lost and who knows what benefit has been lost due to greed and failure to be cognizant of how, short term interests, are destroying our current and future quality of life.

### 2.3.1 FALLACIES ABOUT PLANT BASED OR NATURAL REPELLENTS:

It is commonly assumed that plant-based repellents are safer than DEET because they are natural. However, some natural repellents are safer than others, and it cannot be assumed that natural equates to safe . DEET has undergone stringent testing and has a good safety profile. An estimated 15 million people in the U.K., 78 million people in the U.S.A. , and 200 million people globally use DEET each year . Provided that DEET is used safely, i.e. it is applied to the skin at the correct dose (such as that in a commercial preparation) and it is not swallowed or rubbed into the mucous membranes then it does not cause adverse effects . DEET has been used since 1946 with a tiny number of reported adverse effects, many of which had a history of excessive or inappropriate use of repellent .Its toxicology has been more closely scrutinized than any other repellent, and it has been deemed safe for human use ,including use on children ,pregnant women , and lactating women . In contrast, plant-based repellents do not have this rigorously tested safety record, with most being deemed safe because they have simply been used for a long time. However, many plant-based repellents contain compounds that should be used with caution.

It is also commonly stated that plant based repellents are better for the environment than synthetic molecules. While plant volatiles are naturally derived, distillation requires biomass energy, extraction commonly uses organic solvents that must be disposed of carefully, growing the plants uses agrichemicals, such as fertilizers and pesticides (unless sourced from a sustainable and organic

source). However, if carefully practiced, cash cropping of plants used for repellents provides a vital source of income for small scale farmers in developing countries and can have beneficial environmental impact when planted in intercropping systems to prevent soil erosions. Therefore, it is important to carefully source of repellent plants to avoid pitfalls associated with unsustainable cropping practices. Another common misconception is that chrysanthemum is an effective repellent. It does have a moderate repellent effect when rubbed on the skin, although there are far more effective repellents available that also have a more pleasing odour. The consumption of chrysanthemum however, has been shown to be effective at repelling mosquitoes and anti bacterial property.[9]

### 2.3.2 NATURAL REPELLENTS:

It's very easy to make your own natural mosquito repellent. These natural products will effectively repel mosquitoes, but they require more frequent reapplication (at least every 2 hours) and higher concentrations than DEET. Because of the differences between types of mosquitoes, products that contain multiple repellents tend to be more effective than those containing a single ingredient. As you can see, natural repellents tend to be volatile plant oils.

- Citronella Oil
- Lemon Eucalyptus Oil
- Cinnamon Oil
- Castor Oil
- Rosemary Oil
- Lemongrass Oil
- Cedar Oil
- Peppermint Oil
- Clove Oil
- Geranium Oil
- Possibly Oils from Verbena, Pennyroyal, Lavender, Pine, Cajeput, Basil, Thyme, Allspice, Soybean, and Garlic

Another plant-derived substance, pyrethrum, is an insecticide. Pyrethrum comes from the flowers of the daisy Chrysanthemum.

#### 2.3.2.1 CHRYSANTHEMUM:

**Botanical Name:** Chrysanthemum,Chrysanthemum morifolium

**Scientific classification**

**Kingdom**: Plantae

**(unranked):** Angiosperms

**(unranked):** Eudicots

**(unranked):** Asterids

**Order:** Asterales

**Family:** Asteraceae

**Tribe:** Anthemideae

**Genus:** *Chrysanthemum*

Several varieties of chrysanthemum, ranging from white to pale or bright yellow in color, are used for tea. These include:

- Huángsh n Gòngjú (黄山贡菊 literally "Yellow Mountain tribute chrysanthemum"); also called simply Gòngjú (贡菊)
- Hángbáijú (杭白菊), originating from Tongxiang, near Hangzhou; also called simply Hángjú, (杭菊)
- Chújú (滁菊), originating from the Chuzhou district of Anhui
- Bójú (亳菊), originating in the Bozhou district of Anhui

The flower is called *gek huay* in Thai. In Tamil it is called *saamandhi*.

Of these, the first two are most popular. Some varieties feature a prominent yellow flower head while others do not.

Chrysanthemums were first cultivated in Chima as a flowering herb as far back as the 15th century BC the plant is renowned as one of the Four Gentlemen in Chinese and East Asian art. The plant is particularly significant during the Double Ninth Festival. It is believed that the flower may have been brought to Japan in the 8th century and the Emperor adopted the flower as his official seal. There is a "Festival of Happiness" in Japan that celebrates the flower.

The flower was brought to Europe in the 17th century. Linnaeus named it from the Greek word χρυσός *chrysous*, "golden" (the colour of the original flowers), and ἄνθεμον *-anthemon*, meaning flower.

The common garden "mum" or chrysanthemum flower has been used in China for centuries for its curative properties as well as an energy tisane, or infusion, to stimulate the blood, according to Herbs2000. As with many herbs employed in Asian medicine, chrysanthemum has many medicinal

uses; among its various properties, chrysanthemum is used to treat infections, for eye problems, to lower high blood pressure, for headaches and colds. Chrysanthemum can cause side effects, so consult your doctor before using it.[10]

#### 2.3.2.1.1 ANTIBIOTIC PROPERTIES:

Chrysanthemum flowers have been found to have antibiotic properties under laboratory conditions, leading researchers to think this herb may be effective in the treatment of both staphylococcus and streptococcus bacteria strains.

#### 2.3.2.1.1 OTHER PROPERTIES:

##### 2.3.2.1.1.1 EYE PROBLEMS:

A warm infusion of chrysanthemum flowers may be helpful in relieving eyestrain, blurry vision and dry eyes, according to Clayton College. In addition, it is thought to help prevent and possibly reverse cataracts, according to the "The Green Pharmacy Herbal Handbook." You can drink the tea or apply hot compresses for relief from aching, tired eyes. If you have the actual chrysanthemum blossoms, soak them in hot water for a few minutes and make a poultice by placing them between two pieces of gauze. Place a poultice on each eyelid and relax for 10 minutes for relief from eye pain. Speak to your herbalist or practitioner before using chrysanthemum for eye treatments. If you develop any unusual symptoms, stop using the herb and seek medical advice.

##### 2.3.2.1.1.2 CLEANSING THE BLOOD:

Chrysanthemum flower tea is used by the Chinese to relieve the body of excess build-up of toxins in the blood, according to the City University of New York. Drinking the tea is thought not only to purify the blood, but to provide relaxation of mind and body. Drink a cup of tea for relief from insomnia. Chrysanthemum flowers are often combined in a mixture with honeysuckle, cinnamon, licorice and ginseng to produce a tonic that balances the cooling and warming principle in the body, according to studies in Chinese medicine. Check with your doctor before using chrysanthemum to be sure it is the right herb for your condition.

Chrysanthemum tea is often used to relieve mild fevers and headaches that might arise from excess toxins in the blood, writes Herbs2000. Conditions such as acne and boils may benefit from

chrysanthemum's antiseptic properties by application of a poultice of chrysanthemum flowers to the inflamed lesions.

#### 2.3.2.1.1.3 BLOOD PRESSURE AND CARDIAC CONDITIONS:

Certain herbal tonics made from chrysanthemum are used to relieve hypertension, writes Herbs2000. The tea is also used in Asia to treat concomitant symptoms such as dizziness, light-headedness, tinnitis or ringing in the ears, and headaches associated with changes in blood pressure. In addition, chrysanthemum may be helpful in reducing attacks of angina, artherosclerosis and related cardiac problems, adds Herbs2000. Although there is no scientific research for these claims, anecdotal evidence from hundreds of years of use in China indicates that chrysanthemum may be helpful for those conditions. Always talk to your physician before using herbs for serious conditions, especially if you take conventional medications. Do not stop taking your medications or start taking herbs without the supervision of your doctor.

#### 2.3.2.1.1.4 CULINARY USES:

Yellow or white chrysanthemum flowers of the species *C. morifolium* are boiled to make a sweet drink in some parts of Asia. The resulting beverage is known simply as "chrysanthemum tea" (菊花茶pinyin: júhu chá, in Chinese). Chrysanthemum tea has many medicinal uses, including an aid in recovery from influenza. In Korea, a rice wine flavored with chrysanthemum flowers is called *gukhwaju*(국화주).

Chrysanthemum leaves are steamed or boiled and used as greens, especially in Chinese cuisine. Other uses include using the petals of chrysanthemum to mix with a thick snake meat soup (蛇羹) in order to enhance the aroma.

#### 2.3.2.1.1.5 INSECTICIDAL USES:

Pyrethrum (*Chrysanthemum* [or *Tanacetum*] *cinerariaefolium*) is economically important as a natural source of insecticide. The flowers are pulverized, and the active components called pyrethrins, contained in the seed cases, are extracted and sold in the form of an oleoresin. This is applied as a suspension in water or oil, or as a powder. Pyrethrins attack the nervous systems of all insects, and inhibit female mosquitoes from biting. When not present in amounts fatal to insects, they still appear to have an insect repellent effect. They are harmful to fish, but are far less toxic to mammals andbirds than many synthetic insecticides, except in consumer airborne backyard

applications. They are non-persistent, being biodegradable and also breaking down easily on exposure to light. They are considered to be amongst the safest insecticides for use around food. (Pyrethroids are synthetic insecticides based on natural pyrethrum, e.g., permethrin.)

#### 2.3.2.1.1.6 Environmental uses

Chrysanthemum plants have been shown to reduce indoor air pollution by the NASA Clean Air Study.

#### 2.3.2.1.1.7 Medicinal uses

Extracts of Chrysanthemum plants (stem and flower) have been shown to have a wide variety of potential medicinal properties, including anti-HIV-1, antibacterial and antibiotic.

# METHODOLOGY

## 3.0 METHODOLOGY:

## 3.1 SELECTION OF MATERIAL:

### 3.1.1 COTTON:

Cotton is the world's most important apparel fibre because it has been used since 3000 B.C. It is a fabric that becomes stronger when wet. It is also breathable and makes good clothing for warm weather. Dyes are readily absorbed by cotton cloth, so it's popular for all types of clothing.

Cotton is a natural fabric and is good for people with sensitivity to certain chemicals. It can be grown organically, and it can be recycled. Cotton can easily be blended with other fabrics, including polyester and Lycra. It is suitable for under garments, because it is soft and breathable, and also for work clothes, because it is strong. It can withstand high temperatures, so it can be cleaned and sanitized hence cotton has been chosen for the study.[12]

### 3.1.2 MEDICINAL HERB:

The English word "herb" is from the Sanskrit word "bharb," which means to eat. It also originates from the Latin word "herba," meaning grass or fodder. According to the Merriam Webster dictionary, an herb is " a seed producing annual, biennial, or perennial that does not develop persistent woody tissue," in other words, a plant without bark. Herbs have been used as medicines for centuries. They were kept in dried form in many pharmacies so that they could be used all year. This is why the word "drug" is from the Anglo-Saxon word "drigan," which means to dry. For centuries, herbs have been the principal if not the only medicines used in many countries. Even herbs we use today for seasonings in cooking were originally used as medicines. Herbs have not been used as often with the recent advances in medical technology, but many people have begun to use herbs as medicines due to their medicinal properties.

#### 3.1.2.1 CHRYSANTHEMUM:

**Chrysanthemum cineriaefolium** is derived from the chrysanthemum flower and is a natural source of insecticide. When the flowers are pulverised, active components in the seed cases called pyrethrins are used in the form of an oleoresin, which is a type of plant resin, known as Pyrethrum. Pyrethrums attack the nervous system of all insects, and stop female mosquitoes from being able to

bite. It is biodegradable and considered to be amongst the safest insecticides for use around products hence it was selected as the mosquito repellent agent.

### 3.1.3 SELECTION OF SOLVENTS:

The herbal solution was extracted using the solvents namely ethanol and distilled water for dry extraction method. After the extraction the solution was tested by well diffission method to identify the maximum zone of inhibition found in the herbal solution. Based on the higher zone of activity it has been found that, the distilled water showed the good antibacterial and mosquito repellent property and it was selected for the bulk production.

### 3.1.4 SELECTION OF SUITABLE EXTRACTION METHOD:

A method of separation in which a solid or solution is contacted with a liquid solvent (the two being essential mutually insoluble) to transfer one or more components into the solvent. The extraction method used in this project is dry extraction process

### 3.1.4.1 DRY EXTRACTION PROCESS FOR CHRYSANTHEMUM FLOWER:

The chrysanthemum flower was picked from the plant and sorted. The flowers were allowed to dry in a shade for 5-6 days. Then the dried flowers were powdered. 10gms of chrysanthemum powder was taken in a conical flask and 100ml of solvent (Distilled water) was added to it. Then cotton was plugged into the head of the conical flask and wrapped with the paper so that the evaporation of the solvent can be prevented. Then it was kept inside the shaker for 24 hours.

After 24 hours, the extract was taken from the shaker and filtered into a beaker using a filter paper so that the pure extraction was taken for the further process. Then this extract solution was poured into the petric plates in the hot oven for 3-4 hours for evaporation. The dried extract was scrapped into the powder form and diluted with the distilled water to get the exact extraction solution.

## 3.2 OPTIMISATION OF FINISH PROCESS CONDITIONS

Optimization is the process of finding the greatest or least value of a function for some constraint, which must be true regardless of the solution

Box and Behnken Design Tool

A method for developing a mathematical model used to find combinations of factors that yield optimal business performance. Box-Behnken designs are a type of response surface method, which provides detailed information about the solution space, allowing researchers to better understand the forces affecting the output of the model.

**TABLE-1**

**BOX AND BEHNKEN EXPERIMENTAL DESIGN VARIABLES AND CODED LEVELS**

| VARIABLES | CODED LEVELS | | |
|---|---|---|---|
| | -1 | 0 | +1 |
| TIME X1 | 60 | 90 | 120 |
| TEMPERATURE X2 | 40 | 50 | 60 |
| CONCENTRATION X3 | 30 | 40 | 50 |

The process conditions are optimized by Box and behnken design tool.Taking the extract in different concentrations namely(20%,40%,60%,80%) in a beaker and the time duration of 30mins,60mins,90mins with different temperatures like (30°C,40°C ,50°C) were maintained by keeping the beakers in water bath. Then the fabric was treated with the herbal extraction which was maintained under the conditions and then the agar diffusion test method was carried out to find out the antimicrobial activity in the green solution.

**FORMULA**

Y=

(R= R^2= )

Y=Antimicrobial efficacy of herbal finished samples

X1=Time

X2= Temperature

X3=Concentration

The maximum zone of inhibition obtained from each trial at particular test order was selected as the best parameters for herbal finishing.The herbal extract of green tea plant was applied on cotton fabric by pad dry and microencapsulation technique using the optimized process parameters are described.

**TABLE-2**

**RESPONSE FACTOR**

| TEST RUN ORDER | TEMPERATURE | | TIME | | CONCENTRATION | |
|---|---|---|---|---|---|---|
| | Actual | Coded | Actual | Coded | Actual | Coded |
| 1 | 0 | 90 | 0 | 50 | 0 | 40 |
| 2 | - | 60 | - | 40 | 0 | 40 |
| 3 | + | 120 | + | 60 | 0 | 40 |
| 4 | 0 | 90 | 0 | 50 | 0 | 40 |
| 5 | - | 60 | + | 60 | 0 | 40 |
| 6 | 0 | 90 | + | 60 | - | 30 |
| 7 | 0 | 90 | - | 40 | + | 50 |
| 8 | + | 120 | - | 40 | 0 | 40 |
| 9 | 0 | 90 | + | 60 | + | 30 |
| 10 | + | 120 | 0 | 50 | - | 30 |
| 11 | - | 60 | 0 | 50 | - | 30 |
| 12 | 0 | 90 | - | 40 | - | 30 |
| 13 | + | 120 | 0 | 50 | + | 50 |
| 14 | - | 60 | 0 | 50 | + | 50 |
| 15 | 0 | 90 | 0 | 50 | 0 | 40 |

From the optimization, the zone of inhibition of microbial growth was observed and the maximum zone of inhibition was obtained from the solvent distilled water,50% herbal extract concentration,temp-50°C and duration of 120 mins chosen as the best process conditions to be followed to finish the final product.

### 3.3 SELECTION OF SUITABLE MORDANT:

A mordant is a substance used to set dyes on fabrics or tissue sections by forming a coordination complex with the dye which then attaches to the fabric or tissue. It may be used for dyeing fabrics, or for intensifying stains in cell or tissue preparations.

Recently more number of mordants has been used in order to produce the eco-friendly products. The mordant allows a dye to attain acceptable wash fastness. This dye is used as mordant and is over dyed with other natural dyes to improve fastness of later and hence due to these properties .the ALUM is used as the mordant.

### 3.4 SELECTION OF pH:

pH is a measure of the acidity or basicity of an aqueous solution.[1] Pure water is neutral, with a pH close to 7.0 at 25 °C (77 °F). Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline. Based on the literature the pH was selected as 5.5 for the study.

### 3.5 SELECTION OF MATERIAL LIQUOR RATIO:

In wet processing the ratio of the weight of liquid used to the weight of goods treated.Based on the zone of inhibition the material liquor ratio 1:20 is selected when compared to 1:10 .

### 3.6 SELECTION OF FINISH APPLICATION METHOD ON FABRIC:

The finish was applied on the cotton fabric by two methods

1. Pad-dry-cure Method.
2. Microencapsulation Method, with optimized process conditions.

### 3.6.1 PAD-DRY-CURE FINISH APPLICATION METHOD

The fabric samples were finished with herbal extract using pomegranate mordant as cross linking agent. Chrysanthemum extraction was applied on to the fabric by using the padding mangle with the below mentioned conditions.

- Material liquor ratio=1:20
- Temperature=50°C

- Pressure=20pascal
- Time=2hr.

### 3.6.2 MICROENCAPSULATION FINISH APPLICATION METHOD

Micro-encapsulation is one of the novel methods of getting functional finishes on textiles. It is a process in which the tiny particles or droplets are surrounded by a coating to give small capsules many useful properties.

In a relatively simplistic form, a microcapsule is a small sphere with a uniform wall around it. The material inside the microcapsule is referred to as the core, internal phase, or fill, whereas the wall is sometimes called as shell coating, or membrane micro-encapsulation was done using herbal extract as core material and gum acacia as wall materials. Ten grams of acacia powder was allowed to swell for 15min in 100ml of hot water. To this mixture,50 ml of hot water was added and stirred for 15 min maintaining the temperature between 40°C and 50°C.One and half a gram of core material (herbal extract) was slowly added under stirring condition. Stirring was continued for another 15 min and then 10ml of 20% sodium sulphate and 17% of formaldehyde was added and stirred for 15mins then the mixture was freeze dried in a freezer to develop microcapsules.

Cotton fabric was immersed in the microcapsules solution and padded through pneumatic padding mangle at a pressure of 3psi. Then the treated fabric was dried at 80°C for 5 min.and dried at 80C for 5 min.

## 3.7 SELECTION OF MICRO ORGANISMS:

A microorganism or microbe is a microscopic organism that comprises either a single cell (unicellular) or cell l clusters. Micro-organism are very diverse they include bacteria, fungi, archaea, and protists. Microorganisms live in all parts of the biosphere where there is liquid water, including soil, hot springs, on the ocean floor. Micro organisms aid our bodily processes by helping break down complex food into simpler substances. However, pathogenic microbes are harmful, since they invade and grow within other organisms, causing diseases that kill humans, other animals and plants.The types of the micro organisms are bacteria, fungi,virus,algae and Achaea.

### 3.7.1 SELECTED MICRO ORGANISMS:

#### 3.7.1.1 BACTERIA

- Gram positive bacteria: Staphylococcus aureus

A species of Staphylococcus that produces a golden pigment with some color variations and was commonly found on the skin or nose of healthy people. It is also responsible for a number of phylogenic infections, such as boils, carbuncles, and abscesses. *S. aureus* infections have become increasingly more difficult to treat because of the development of resistance to pencillin-related antibiotics. These bacteria are called *methicillin-resistant S. aureus* or MSRAs.

- Gram negative bacteria: Escherichia coli

A genus of widely distributed gram-negative bacteria in the family *Enterobacteriaceae. E. coli (Escherichia coli)* was one of several types of bacteria that normally inhabit the intestine of humans and animals (commensal organism). Some strains of *E. coli* are capable of causing disease under certain conditions when the immune system is compromised or disease may result from an environmental exposure. An *E. coli* infection may also arise due to environmental exposure. Infections with this type of bacteria pose a serious threat to public health with outbreaks arising from food and water that has been contaminated with human or animal feces or sewage. Some neurological symptoms such as drowsiness, seizure and coma may occur.

From the above properties bacteria was selected for the study.

## 3.8 SELECTION OF ANTIBIOTICS

Antibiotics may be informally defined as the subgroup of anti-infectives that are derived from bacterial sources and are used to treat bacterial infections. Other classes of drugs, most notably the sulfonamides, may be effective antibacterial. Other antibiotics may be useful in treating protozoal infections.Antibiotics are used for treatment or prevention of bacterial infection.The anti biotic were selected based on the type of bacteria and fungi used.

- Penicillin Anti-biotic for Staphylococcus aureus.
- Tetracycline Anti-biotic for Escherichia coli.

## 3.9 EVALUATION METHODS:

### 3.9.1 PRELIMINARY TESTS FOR MOSQUITO REPELLENCY:

### 3.9.1 .1 CAGE TEST:

The untreated, micro and pad herbal treated samples were tested for the mosquito repellency. The fabric samples were taken in the dimension of 10*10 inches and placed in a transparent cage. The cage consists of about 30 mosquitoes. The observation was made on number of mosquitoes landed on fabric was observed at the various interval of 30min, 60min, 90min, and 120min.

### 3.9.2 PRELIMINARY TESTS FOR ANTI MICROBIAL COMPOUNDS

#### 3.9.2.1 AGAR WELL DIFFUSION TEST

2.8 gms of Nutrient Agar powder is weighed and mixed with 100ml of distilled water in a conical flask. Then cotton is plugged into the head of the conical flask and wrapped with the paper. The Petrie Plates are cleaned well, wiped with ethanol and wrapped in a paper. The Nutrient Agar, Petric plates and the tips for pipette out the bacteria should be Autoclaved at a temperature of 121°C for 15 mins.

The Laminar air flow chamber is wiped with ethanol and then the sterilized Agar and plates are kept inside the chamber for cooling.

The Agar was solidified by pouring it onto the petric plates.100µl of Staphylococcus aureus bacteria is pipette out and poured into the solidified Agar. Using the L-rod the bacteria is spreaded evenly with the help of turn table. Similarly the 100µl of Escherichia coli bacteria is pipette out and poured into the solidified Agar. Using the L-rod the bacteria is spreaded evenly with the help of turn table. Then the well is cut on the Agar. Then the extraction solution of is pipette out in the concentration of 50µl,100µl and 150µl. Penicillin Anti-biotic disc for Staphylococcus aureus and Tetracycline Anti-biotic disc for Escherichia coli is placed on the Agar to check its inhibition. Then the petric plates are kept in the incubator at 37°C for 24hours.

After 24hrs, the zone of inhibition is seen clearly in the plates and it is measured. Higher the zone of inhibition higher the anti bacterial activity.

### 3.10 ASSESMENT OF MOSQUITO REPELLENCY AND ANTI BACTERIAL PROPERTY TEST ON CHRYSANTHEMUM FINISHED FABRICS

#### 3.10.1.1MOSQUITO REPELLENT TEST FOR PAD AND MICRO TREATED SAMPLE AND UNTREATED SAMPLE (U.S. PATENT 5,198,287):

**U.S. PATENT 5,198,287 AND USDA LABORATORY METHOD:**

**Insect Used: Female Mosquito** - Anopheles species

**No. of Insects Released in Laboratory Tent:** 12 per 10-20 grams of Fabric/half a metre

**No. of hrs. of Incubation:** 3 hrs (intermittent).

**PROCEDURE:**

3 hrs exposure of mosquito was carried out in a tent made by the provided fabric. Every 1 hour, observations were made about the movements, biting tendency and survival of mosquitoes

### 3.10.2 LNVITRO CYTOTOXICITY TEST:

**SAMPLE PREPARATION:**

1gm sample was sterilized at 121oC for 15mins to which 10 ml extraction medium was added (0.1g/ml) and incubated at 37oC for 24 hrs and the extract pH is adjusted to 7.5 with 0.1N NaOH.

**PROCEDURE:**

L929 cells seeded in 96 well plates at a concentration of 10,000 cells per 100 prl of MEM culture medium per well were maintained in culture for 24 hours to form a semi confluent layer and were exposed to the test material over a range of concentration. After 24 hours exposure, Formazan formation is determined for each treatment concentration and compared to that determined in growth control.

For each treatment the percentage inhibition of growth is calculated by Viability of cells as per formula -

Viability Percentage = 100 x O. D. 570 nm for extract/ O. D. 570 nm for blank

### 3.10.3 ANTI MICROBIAL TEST METHODS:

### 3.10.4 AATCC147-QUALITATIVE-ANTI-BACTERIAL TESTING:

**AGAR DIFFUSION TEST:**

5.6gms of Nutrient Agar powder is weighed and mixed with 200ml of distilled water in a conical flask. Then cotton is plugged into the head of the conical flask and wrapped with the paper.The Petric Plates are cleaned well,wiped with ethanol and wrapped in a paper.The Nutrient Agar, Petric plates and the tips for pipette out the bacteria should be Autoclaved at a temperature of 121°C for 15 mins.

The Laminar air flow chamber is wiped with ethanol and then the sterilized Agar and plates are kept inside the chamber for cooling.

The Agar was solidified by pouring it onto the petric plates.100µl of Staphylococcus aureus bacteria is pipette out and poured into the solidified Agar. Using the L-rod the bacteria is spreaded evenly with the help of turn table. Similarly the 100µl of Escherichia coli bacteria is pipette out and poured into the solidified Agar. Using the L-rod the bacteria is spreaded evenly with the help of turn table.Then the treated fabrics are placed in the marked places . Penicillin Anti-biotic disc for Staphylococcus aureus and Tetracycline Anti-biotic disc for Escherichia coli is placed on the Agar to check its inhibition.Then the petric plates are kept in the incubator at 37°C for 24hours.

After 24hours ,the zone of inhibition is seen clearly in the plates and it is measured.Higher the zone of inhibition higher the anti bacterial activity.

### 3.10.5 AATCC 100-QUANTITATIVE- BROTH DILUTION TEST

**Procedure:**

Treated and untreated samples were taken for broth dilution test.8 conical flasks are taken In each conical flask , 50ml of Nutrient broth powder is weighed and mixed with distilled water.Then the solution is stirred well.100µl Staphylococcus aureus bacteria is added into 3 conical flasks which contains the treated and untreated samples. Similarly 100µl Escherichia coli bacteria is added into 3 conical flasks which contains the treated and untreated samples.The 100µl Staphylococcus aureus and Escherichia coli is added to the remaining 2 conical flasks which is kept without adding the samples for measuring the control(C).Then the flasks are kept in a shaker for 24hours under medium speed at room temperature.

2g of Nutrient broth is diluted with small amount of distilled water to measure the blank which used to set zero caliberation.Before taking the readings the machine is caliberated to 700nm.The readings are noted using the calorimeter.Reduction percentage of the broth dilution is calculated using the formula.

**Formula:**

Reduction %=C-T/C*100

Where C=control of respective bacteria.

T=value of tested fabric.

### 3.10.6 STATISTICAL ANALYSIS:

**Statistics** is the study of the collection, organization, analysis, and interpretation of data. It deals with all aspects of this, including the planning of data collection in terms of the design of surveysand experiments.Hence the unfinished and herbal finished fabrics were subjected to various test Anova,T-test ,to evaluate their properties.The significance of these results are discussed in the chapter 4.

### 3.10.7 OBJECTIVE EVALUATION

The Objective evaluation tests were carried out by laboratory examination by using various instruments, to study the various physical properties like mechanical, comfort, absorbency and wash durability of the fabric before and after finishing treatment.

### 3.10.8 FABRIC PARAMETERS

- GSM of the fabric=144
- EPI(ends per inch)=72
- PPI(picks per inch)=63
- Fabric Warp Count=40
- Fabric Weft Count=38
- Fabric Cover Factor=17.46

## 3.11 ASTM D5305- FABRIC TENSILE STRENGTH:

**MACHINE USED**: UNISTRETCH TENSILE TESTER

**Principle:** Constant rate of loading

Strength is the ability of the fabric to withstand stress and strain applied at the time of processing the fabric and the usage of the fabric.

**Procedure:**

Spread the given fabric sample on the table.Remove the selvedges and wrinkles from the fabric.Prepare samples of size 135mm*25mm.Select the Mag Unistretch software icon in the computer.Select fabric tensile strength test and select new in the software.Feed the test parameters like type of fabric,machine speed etc...Transfer the data to the machine shows ready in the screen.Fix the sample in the top and bottom jaws applying required weight at the bottom of the fabric.Click on start button to start the test.Record the readings from the computer.

## 3.12 ASTM D 4966- FABRIC ABRASION RESISTANCE:

**Abrasion resistance:**

Abrasion is one of aspect of wear and is the rubbing away of the component fibres and yarns of the fabric.

Abrasion may classified into

1. Flex abrasion (the flat area of the fabric is abraded)
2. Edge abrasion (the kind of abrasion occurs at folds and collars )
3. Flat abrasion (rubbing is accompanied by flexing and bending)

**Procedure**

1. Prepare sample of 38mm diameter.
2. The initial weight of the sample is found using electronic balance.fix the sample in the mushroom shaped sample holder.
3. Fix the mushroom shaped sample holder in the machine in such a way that the sample are exposed to abradent material (emery paper).
4. Select suitable weight and place it on the sample holder.
5. Start and run the machine for 50 cycles.
6. Remove the sample holder from the machine and remove the sample from sample holder
7. Calculate the weight loss and abrasion resistance from the given formula

**Formula**

1. (Weight loss % = (initial weight – final weight ) / initial weight) *100
2. Abrasion resistance = 100 – weight loss

## 3.13 ASTM D 1388-FABRIC STIFFNESS:

Fabric stiffness indicates the resistances of the fabric to bending and it is a key factor in the study of handle and drape .cantilever principle of working is used to determine the stiffness of fabrics stiffness is related with handle and drape of the fabric.

**Procedure**

1. Prepare sample from the given sample in warp and weft direction
2. Place the specimen on the platform in the stiffness tester and place the template over the fabric sample in such a way that the zero mark in the template should coincide with the datum line in the instrument.

3. Push both the template and fabric in forward direction.
4. The fabric will tend to drop on are the edge of the instrument when viewed in mirror.
5. Record the reading from the template.

**Formula**

Weight of the fabric(W2)= g/cm^2

Flexural rigidity(G)=W2*C^3*10^3 mg.cm

Overall Flexural rigidity= (G1*G2)

Bending Modulus(Q)=12G*10*-6/g^3 Kg/sq.cm

Where g=thickness in cm.

### 3.14ASTM D 1777-FABRIC THICKNESS:

**Principle:**

The fabric is kept between the two plane parallel plates and a known arbitrary pressure ia applied between the plates and maintained .Then the distance between the plates is precisely measured.

**Procedure:**

The presser foot and anvil are cleaned by a clean paper.If required,weights are added to presser foot and the guage is set to zero.No specimen preparation is required.But the selvedges and the creased areas should be avoided.If possible,the cloth may be conditioned for about 24 hours in standard atmosphere.Atleast ,thickness is measured at 5 different places and the mean value is reported.

### 3.15 ASTM 1670 - FABRIC DRAPE:

**Drape:**

Drape is the ability of a fabric to a assume a graceful appearance in use. Drapability of a fabric can be determined using the instrument drape meter and is expressed in the terms of coefficient.

**Procedure :**

1 .prepare the sample of required size

2 . open the transparent lid of drape meter

3 .fix the sample over the bottom supporting disc.(platform should be at lowest position)

4 . place the top supporting disc and secure it by tightening the screw

5 .release the supporting disc unit and allow to raise by means of a compressed spring . This allows the edge of the fabric to drape freely under its own weight

6 .close the lid and place a white paper over the lid. switch on the light

7. draw the outline of the projected and area specimen .calculate the drape coefficient from the formulate.

**Formula:**

D = Ws – Wd / WD –Wd

Ws – weight of paper whose area is equal to the projected area of specimen

Wd – weight of paper whose area is equal to the area of supporting disc

WD – weight of open whose area is equal to the area of the specimen

### 3.16 ASTM D737-AIR PERMEABILITY:

Air permeability test provides the air permeability property of the composite. Air permeability is usually tested by shierly air permeability tester.

**Procedure:**

Choose the set of rings of given area (4.10cm) for which the test is conducted. Take the ring from one set, which have groove at one face and rubber lining at other face and then place this ring on the groove in the sample holder the grooves in the ring must be download.

The other mount to the other part of the sample holder by using the knurling bolts. Place sample on the bottom sample holder. Place two parts of the sample holder in such a way the two rings have same axis. Move this screw so that two rings are tightened. Close all the rotometers by the knob, which are the attached to the rotometers.

Put the water in the upper cup which is provided at the left side of the machine (in manometer type model). Set the zero in digital manometer. Switch on the vacuum pump. Slightly open the knobs of the rotometer and set the given suction pressure in the manometer (10mm of the water column)

Take the rotometer reading (eg: if the rotometer reading are 20,7and 0.5 LPM then the overall reading will be 20+7+0.5=27.5 LPH ). Take at least 10 readings from the each sample and then determine the mean. Repeat same procedure for other specimen

**Formula:**

R = r * 1000 / 60 * 60 * A

r = rotometer reading (R1+R2+R3)

A = area of cross section

### 3.17 ASTM D 2692-WICKING:

The ability of a material to not only absorb sweat but to actually move it away from our bodies. For this test, strips of material are clipped to a bar at a fixed height above beakers of water. The distance the water travels up the material is measured at various intervals over thirty minutes. A good "wickable" fabric will transport all the water straight up.

**Procedure :**

1. Prepare the fabric specimens of size 5"*1" (warp and weft)
2. Suspend the specimens vertically with its ends dipping into the solution
3. Observe the effect for warp and weft directions at different height.
4. Calculate the average time.

### 3.18 SEM STUDY

The SEM study is mainly used to identify the finished molecules present in the fabric samples. According to Samanta et al. (2007) and Thilagavathi et al. (2005) the unfinished, pad and micro encapsulation finished samples of all the herbs were subjected under the study. The pad dry and micro encapsulation finished samples were analyzed using high resolution Scanning Electron Microscope JEOL M JSM-6360 with suitable accelerating voltage and magnification and used to conform the binding of microcapsules and alignment onto the fabric sample. The microscopic analysis was carried out with 3KV – 6 KV of voltage and below five vacuum levels as described by Wasif and Laga (2009). The pad dry and microcapsules were examined under the X450, X500, X1000, X3000, X7500, X10000 magnifications using light microscopy with image processing technique to analyze the morphology of capsules. The scanning was done for thirty minutes for each sample with four different magnification depending on the thickness of the sample and images were pictured and presented in the Chapter – 4 Results and Discussion.

### 3.19 WEAR STUDY

The study was conducted by wearing the finished product for a certain period .

**3.19.1 Selection of persons:** Person With O+ve blood group

**3.19.2 selection of age group:** 18-40

**3.19.3 Selection of hospital:** Indian ayurvedic hospital and research ltd., coimbatore

**3.19.4 Number of persons:** 10

**3.19.5 Type of garment:** Full sleeve night coat

**3.19.6 Wear study period:** 10 hrs(5pm to 3am)

## 3.20 CONSTRUCTION PROCEDURE:

## DRAFTING PROCEDURE:

## COAT:

A garment for the upper part of the body usually having a collar, sleeves, a front opening, and a tail long enough to be tucked inside trousers or a skirt

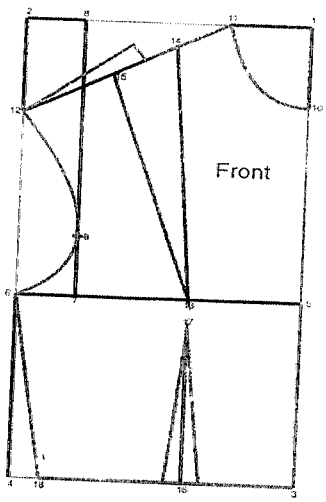
## YOKE:

Draw a rectangle ABCD with AB=1/2 shoulder ,BC on fold and Ad=1/8 th chest.

Mark BE=1/6 th Neck

Mark the point F on BC,where BF=1/2 BE

Mark AG on AD line with AG=1"-11/4"




## FRONT BODICE

Draw the rectangle ABCD eiht BC on fold AB=1/4 th chest+2"

BE=1/6 th neck

BF=1/6/ th neck+1/4"

Mark BG on AB line where BG=1/2 shoulder

Mark armhole AH=1/4 th chest

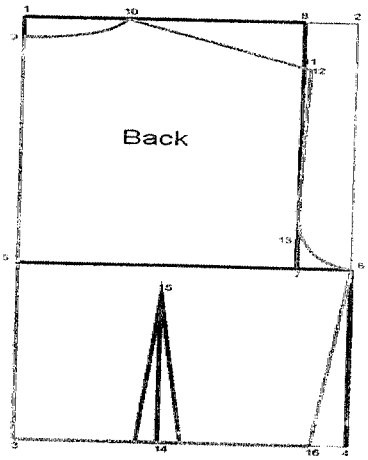
Mark shoulder drop GJ

Mark K,JK=1/3 rd of GI

Connect JKH

Join EJ

## BACK BODICE




The Back Bodice is drafted same as the front shirt bodice by subtracting the length of yoke from shoulder on AD.

**PLACKET**

Mark ½" width of front placket+one full of placket width+1/2" seam allowance

**SLEEVE**

Draw a rectangle ABCD with AD on fold

Mark AB=1/4 th chest,where AB=sleeve length-wdith of cuff

BE=1/2 of chest

Join AE

Divide AE into 4 equal parts by points a,b,c

Aa'=1/2"

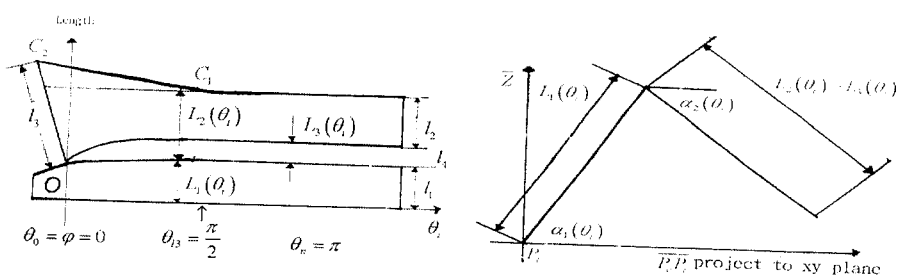
Bb'=1/2"

Cc'=1/2"

Join Aa'b'cE for front armhole

Join Aabc'E for back armhole

**COLLAR**



Draw a rectangle ABCD with AD on fold

AB=1/2 neck+1/4"

AD=25/8"& AE=11/2"

E'=1/8" below E

Join E to BC and mark F

Extend f'&c

Mark a line=1/2" of placket

Mark it as G and H

From G mark ma point k=1/4" below

From H mark a point ¼" above

CJ=2"

From J mark a point k=1/4" below

Extend the line B1 and ½" above and outside by ½"

**CUFF**

Draw a rectangle ABCD with AB=cuff length and BC=cuff width

AD=on fold

**POCKET**

Draw a rectangle ABCD

AB=CD=2 1/4"

AC=BD=5 1/2"

### 3.19 WASH DURABILITY TEST

**Procedure:**

The treated fabric is hand washed using the commercial detergent such as 1,3 ,5,10,15,20,25 and 30 washes and dried.Then the fabric si categorized according to their washes and checked for anti microbial activity.5.6gms of Nutrient Agar powder is weighed and mixed with 200ml of distilled water in a conical flask. Then cotton is plugged into the head of the conical flask and wrapped with the paper.The Petric Plates are cleaned well,wiped with ethanol and wrapped in a paper.The Nutrient Agar, Petric plates and the tips for pipette out the bacteria should be Autoclaved at a temperature of 121°C for 15 mims.The Laminar air flow chamber is wiped with ethanol and then the sterilized Agar and plates are kept inside the chamber for cooling.

The Agar was solidified by pouring it onto the petric plates.100µl of Staphylococcus aureus and Escherichia coli bacteria is pipette out and poured into the solidified Agar.Using the L-rod the bacteria is spreaded evenly with the help of turn table.similarly 100µl of Aspergillus oryzea fungi is

pipette out and poured into the solidified Agar.Using the L-rod the fungi is spreaded evenly with the help of turn table.Then the washed fabric is kept on the Agar to measure the zone of inhibition. Then the petric plates are kept in the incubator at 37°C for 24hrs.After 24hrs ,the zone of inhibition is seen clearly in the plates and it is measured.Higher the zone of inhibition higher the Anti microbial activity.

### 3.21 FEED BACK

After the use of the product,the feedback was obtained from the certain persons and the doctor using the questionnaire as shown in the Appendix 4.

# RESULTS AND DISCUSSION

# 4 RESULTS AND DISSCUSSION

## 4.1 PRELIMINARY ASSESSMENT OF MOSQUITO REPELLENY IN CAGE TEST

**TABLE- 3**

| S.NO | TIME (mins) | NO OF MOSQUITOS OBSERVATED IN THE UN TREATED FABRIC | NO OF MOSQUITOS OBSERVATED IN THE PAD TREATED FABRIC | NO OF MOSQUITOS OBSERVATED IN THE MICRO TREATED FABRIC |
|---|---|---|---|---|
| 1 | 30 | 5 | 0 | 0 |
| 2 | 60 | 7 | 0 | 0 |
| 3 | 90 | 13 | 0 | 0 |
| 4 | 120 | 18 | 1 | 0 |

From the above table it has been concluded that the pad and micro treated fabric showed good mosquito repellency when compared to untreated fabric. In this cage test the mosquitoes was observed in 30,60.90 and 120 min, the untreated fabric does not show the repellent property, in 120 min time duration the 18 mosquitoes were touched the fabric surface and one mosquito in pad treated fabric.

## 4.2 PRELIMINARY TESTS FOR ANTI-BACTERIA COMPOUNDS

## 4.2.1 WELL DIFFUSION METHOD

**TABLE-4**

**CHRYSANTHEMUM –AATCC 147- WELL DIFFUSION TEST- (STAPHYLOCOCCUS AUREUS)**

| MEDICAL HERB | ANTIBIOTIC Tetracyclene (10μg) | CONCENTRATION OF HERBAL SOLUTION (μl) | SOLVENTS | |
|---|---|---|---|---|
| | | | ETHANOL | DISTILLED WATER |
| | | | ZONE OF INHIBITION (mm) | |
| CHRYSANTHEMUM | 30 | 50 | 22 | 24 |
| | | 100 | 19 | 28 |
| | | 150 | 20 | 30 |

From the above table, we conclude that the solvent distilled water has showed the maximum zone of inhibition when compared to other solvents. The zone of inhibition was also compared with antibiotic, it was showed equal zone in 150μl against staphylococcus bacteria.

**TABLE-5**

**CHRYSANTHEMUM –AATCC 147- WELL DIFFUSION TEST- (E.COLI BACTERIA)**

| MEDICAL HERB | ANTIBIOTIC Tetracyclene (10μg) | CONCENTRATION OF HERBAL SOLUTION (μl) | SOLVENTS | |
|---|---|---|---|---|
| | | | ETHANOL | DISTILLED WATER |
| | | | ZONE OF INHIBITION (mm) | |
| CHRYSANTHEMUM | 12 | 50 | 21 | 28 |
| | | 100 | 26 | 27 |
| | | 150 | 24 | 29 |

From the above table, we conclude that solvent water has more zone of inhibition when compared to other solvents. The best zone of inhibition is taken by comparing the zone with the antibiotic's zone of inhibition. Thus from the two different bacteria usage, the Escherichia coli has got more zone of inhibition than staphylococcus aureus which prevents the growth of bacteria. From this well diffusion test results the maximum zone of inhibition was obtained in the solvent distilled water and 150 μl concentration.

**U.S. PATENT 5,198,287 AND USDA LABORATORY METHOD MOSQUITO REPELLEENT**

**TABLE-6**

**U.S. PATENT 5,198,287 AND USDA LABORATORY METHOD MOSQUITO REPELLEENT**

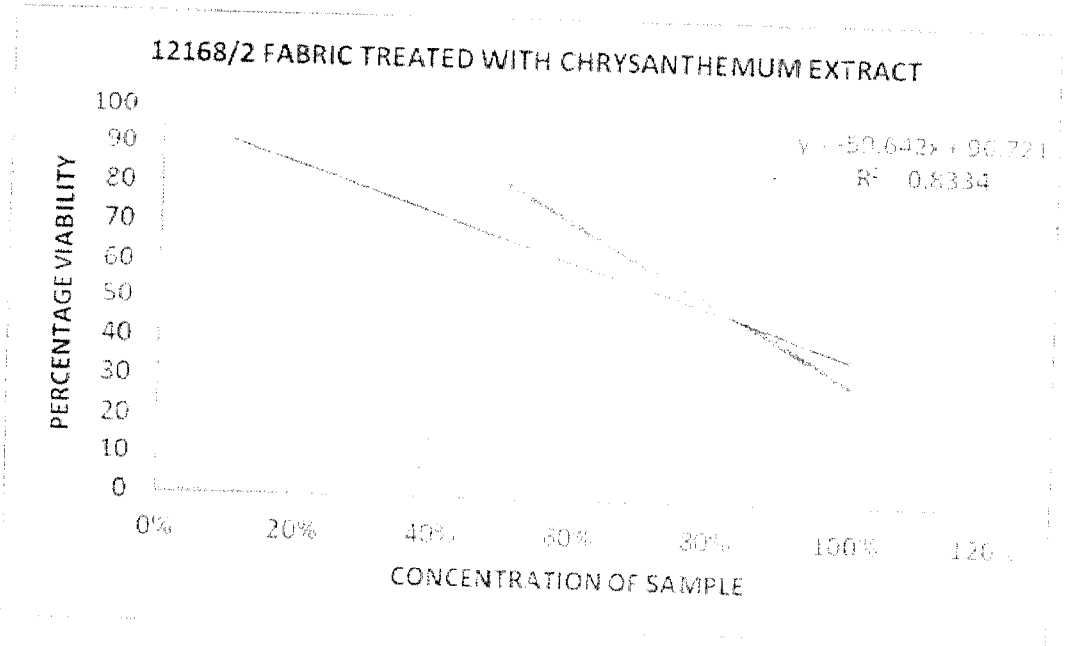
| Sample Identification | Total No. Knock Down | Total No. Unable to Fly | Bite Counts per 3 mins. Exoosure | Percentage Repellency Efficiency |
|---|---|---|---|---|
| Control sample | Nit | 0 | 10 | 00 |
| Fabric sample treated with Ghrysanthemum | NIL | 01 | 02 | 30 |

**LNVITRO CYTOTOXICITY TEST**

**TABLE-7**

**LNVITRO CYTOTOXICITY TEST**

| FABRIC TREATED WITH CHRYSANTHEMUM EXTRACT | Negative control | Positive control | Growth Control | 10% | 25% | 50% | 100% |
|---|---|---|---|---|---|---|---|
| Percentage of cell viabilitv over control | - | 4.4 | 100 | 83.06 | 132.07 | 82.67 | 30.92 |
| p-value | - | - | - | 0.23 | 0.08 | 0.43 | 0.16 |




### 4.3.2.1 AATCC 147 –ANTI –BACTERIAL TESTING

**TABLE-8**

**CHRYSANTHEMUM –AATCC 147- AGAR DIFFUSION TEST- (STAPHYLOCOCCUS AUREUS)**

| MEDICAL HERB | ANTIBIOTIC Tetracycline (µg) | TIME (mins) | STAPHYLOCOCCUS AUREUS | |
|---|---|---|---|---|
| | | | ETHANOL | DISSTILLD WATER |
| | | | ZONE OF INHIBITION(mm) | |
| CHRYSANTHEMUM | 28 | 30 | 15 | 18 |
| | | 60 | 16 | 25 |
| | | 90 | 18 | 27 |

From the above table, we conclude that the solvent distilled water has showed the maximum zone of inhibition when compared to other solvents. The zone of inhibition was also compared with antibiotic, it was showed that equal as maximum zone was observed in 90 mins against Staphylococcus bacteria.

## TABLE-9

## CHRYSANTHEMUM –AATCC 147- AGAR DIFFUSION TEST- (E.COLI BACTERIA)

| MEDICAL HERB | ANTIBIOTIC Tetracycline (µg) | TIME (mins) | E.COLI | |
|---|---|---|---|---|
| | | | ETHANOL | DISSTILLD WATER |
| | | | ZONE OF INHIBITION(mm) | |
| CHRYSANTHEMUM | 23 | 30 | 12 | 15 |
| | | 60 | 13 | 20 |
| | | 90 | 16 | 23 |

From the above table, we conclude that the solvent distilled water has showed the maximum zone of inhibition when compared to other solvents. The zone of inhibition was also compared with antibiotic, it was showed that equal as maximum zone was observed in 90mins against E.coli bacteria.

## TABLE-10

## OPTIMIZATION OF PROCESS PARAMETERS

| TIME (mins) | Temperature In (C) | CONCENTRATION OF HERB(ml) | ZONE OF INHIBITION(mm) |
|---|---|---|---|
| 30 | 30 | 4 | 11 |
| 30 | 30 | 4 | 12 |
| 60 | 40 | 2 | 11 |
| 60 | 40 | 6 | 12 |
| 90 | 60 | 6 | 14 |
| 90 | 60 | 8 | 14 |

### 4.3.2.2 AATCC 100- BROTH DILUTION TEST

**TABLE-11**

**BROTH DILUTION TEST**

| SAMPLES | CONTROL | | TEST RATING | | | | REDUCTION OF BACTERIAL GROWTH (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | STAPH.AUREUS | | E.COLI | | STAPH. AUREUS | | E.COLI | |
| | STAPH | E.COLI | 0 hr | 1 hr | 0 hr | 1 hr | 0 hr | 1 hr | 0hr | 1 hr |
| Un treated | 0.98 | 0.78 | 0.44 | 0.52 | 0.78 | 0.68 | 55.10 | 46.93 | 0 | 15.70 |
| Pad treated | 0.98 | 0.78 | 0.43 | 0.48 | 0.48 | 0.49 | 57.14 | 54.00 | 65.9 | 33.19 |
| Micro treated | 0.98 | 0.78 | 0.30 | 0.33 | - | 0.44 | 67.20 | 67.30 | 98.5 | 45.87 |

**STATISTICAL ANALYSIS:**

Anova: Single Factor

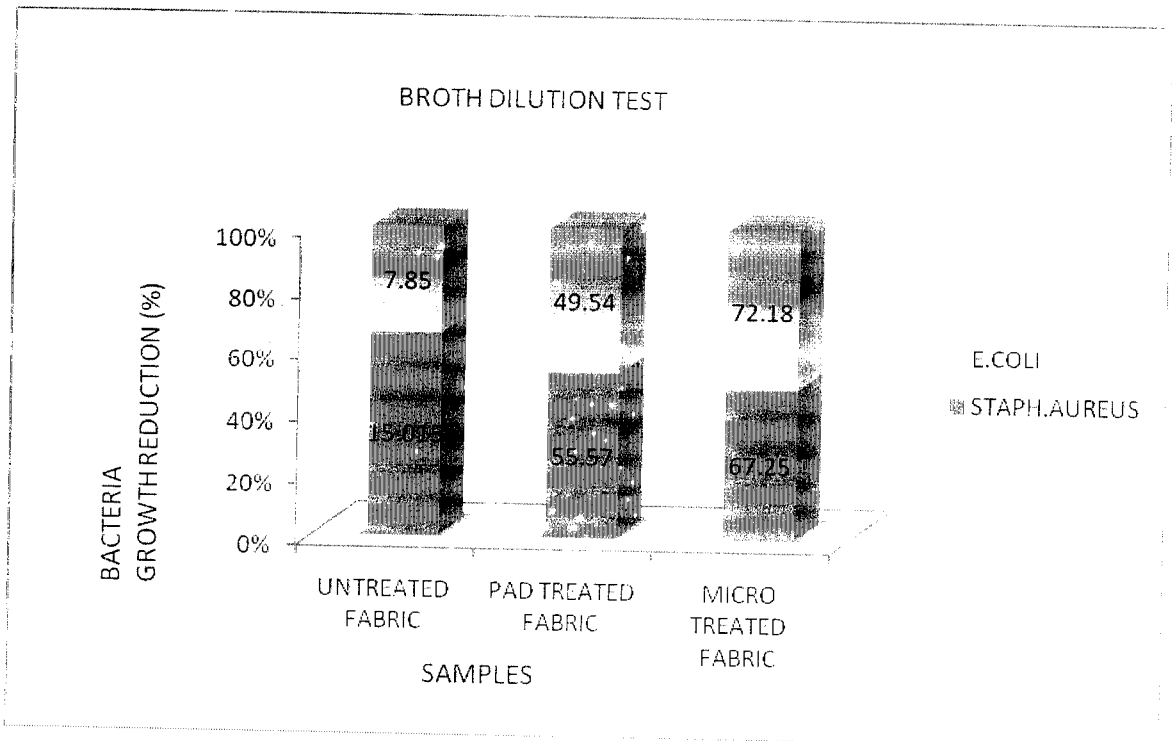
SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| UNTREATED FABRIC | 4 | 117.73 | 29.4325 | 673.2789 |
| PAD TREATED FABRIC | 4 | 210.23 | 52.5575 | 192.0675 |
| MICRO TREATED FABRIC | 4 | 278.87 | 69.7175 | 469.7726 |

ANOVA

| *Source of Variation* | *SS* | *Df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 3269.483267 | 2 | 1634.742 | 3.673249 | 0.068184 | 4.256495 |
| Within Groups | 4005.356825 | 9 | 445.0396 | | | |
| Total | 7274.840092 | 11 | | | | |

## GRAPHICAL REPRESENTATION:




The reduction % of bacterial growth was observed from broth dilution test for two bacterium, Staphylococcus Aureus and E.Coli. The reduction of bacterial growth is much higher for the pad and micro treated samples compared to the untreated . the statistical analysis also showed good antibacterial activity in chrysanthemum pad and micro treated samples.

### 4.4.1 BOX- BEHNKEN DESIGN

**TABLE – 12**

**BOX- BEHNKEN DESIGN**

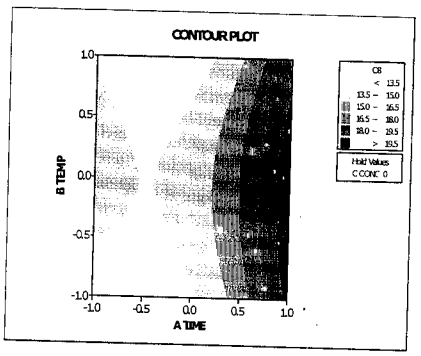
| PROCESS CONDITIONS | LOW(-1) | MEDIUM(0) | HIGH(1) |
|---|---|---|---|
| TEMPERATURE | 40 | 50 | 60 |
| TIME | 60 | 90 | 120 |
| CONCENTRATION | 30 | 40 | 50 |

**TABLE-13**

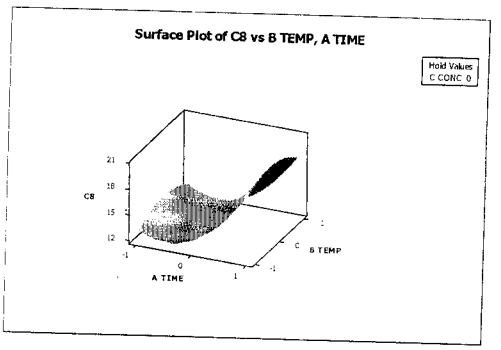
| TEST RUN ORDER | TEMPERATURE | | TIME | | CONCENTRATION | |
|---|---|---|---|---|---|---|
| | Actual | Coded | Actual | Coded | Actual | Coded |
| 1 | 0 | 90 | 0 | 50 | 0 | 40 |
| 2 | - | 60 | - | 40 | 0 | 40 |
| 3 | + | 120 | + | 60 | 0 | 40 |
| 4 | 0 | 90 | 0 | 50 | 0 | 40 |
| 5 | - | 60 | + | 60 | 0 | 40 |
| 6 | 0 | 90 | + | 60 | - | 30 |
| 7 | 0 | 90 | - | 40 | + | 50 |
| 8 | + | 120 | - | 40 | 0 | 40 |
| 9 | 0 | 90 | + | 60 | + | 30 |
| 10 | + | 120 | 0 | 50 | - | 30 |
| 11 | - | 60 | 0 | 50 | - | 30 |
| 12 | 0 | 90 | - | 40 | - | 30 |
| 13 | + | 120 | 0 | 50 | + | 50 |
| 14 | - | 60 | 0 | 50 | + | 50 |
| 15 | 0 | 90 | 0 | 50 | 0 | 40 |

## 4.4 OPTIMISATION PROCESS CONDITIONS

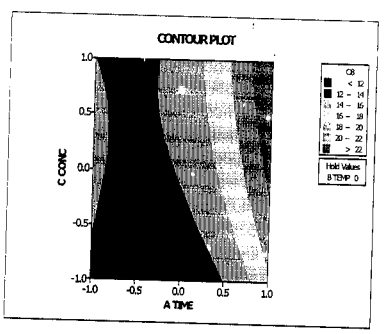
TIME VS TEMPERATURE-1



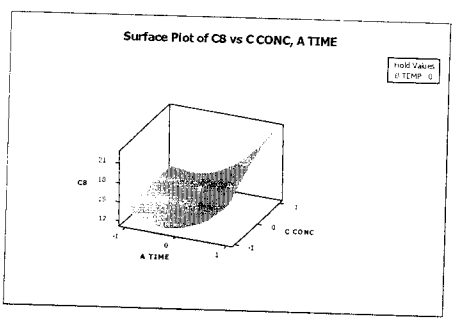

TIME VS TEMPERATURE-2




TIME VS CONCENTRATION-1

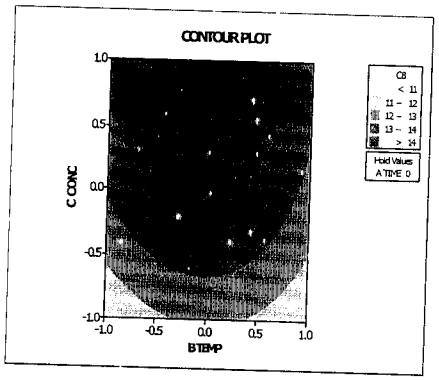


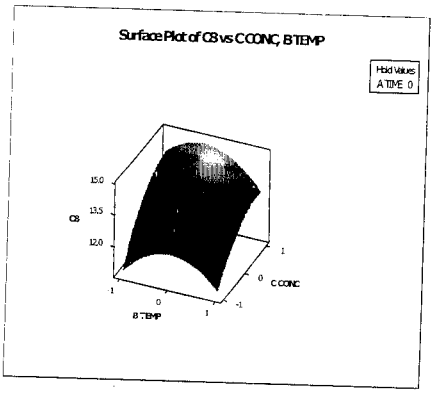

TIME VS CONCENTRATION - 2




TEMPERATURE VS CONCENTRATION -1

TEMPERATURE VS CONCENTRATION -2




With reference to the box and benhan design analysis and the surface plot and contour plot of graphical representation showed the optimum conditions of time 120min, temperature 50c and concentration 50%. This optimised conditions were used for the application of finish on fabric for final product development.

## 4.5 OBJECTIVE EVALUATIONS

### 4.5.1 PHYSICAL PROPERTIES

#### 4.5.1.1 FABRIC PARTICULARS

- GSM of the fabric=144
- EPI(ends per inch)=72
- PPI(picks per inch)=63
- Fabric Warp Count=40
- Fabric Weft Count=38
- Fabric Cover Factor=17.46

#### 4.5.1.3 FABRIC THICKNESS

**TABLE – 14**

**FABRIC THICKNESS**

| S.NO | THICKNESS OF UN TREATED FABRIC (mm) | THICKNESS OF PAD TREATED FABRIC(mm) | THICKNESS OF MICRO TREATED FABRIC(mm) |
|---|---|---|---|
| 1 | 0.38 | 0.38 | 0.39 |

| | | | |
|---|---|---|---|
| 2 | 0.39 | 0.40 | 0.38 |
| 3 | 0.39 | 0.37 | 0.41 |
| 4 | 0.37 | 0.38 | 0.38 |
| 5 | 0.40 | 0.36 | 0.38 |
| 6 | 0.39 | 0.38 | 0.39 |
| 7 | 0.38 | 0.40 | 0.40 |
| MEAN | 0.37 | 0.38 | 0.39 |

**TABLE-15**

**GAIN OR LOSS % OF FABRIC THICKNESS**

| S.NO | SAMPLES | MEAN OF FABRIC THICKNESS | GAIN OR LOSS OVER ORIGINAL | % GAIN OR LOSS |
|---|---|---|---|---|
| 1 | PAD TREATED | 0.38 | 2.702702703 | 2.322702703 |
| 2 | MICRO TREATED | 0.39 | -5.405405405 | -0.39 |

**STATISTICAL ANALYSIS:**

Anova: Single Factor

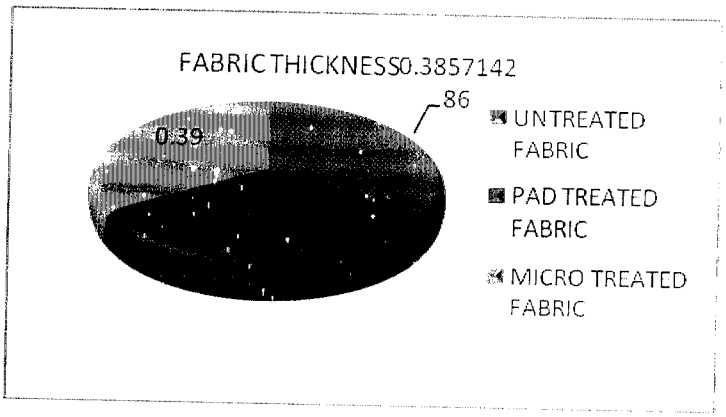
SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| UNTREATED FABRIC | 7 | 2.7 | 0.385714 | 9.52E-05 |
| PAD TREATED FABRIC | 7 | 2.67 | 0.381429 | 0.000214 |
| MICRO TREATED FABRIC | 7 | 2.73 | 0.39 | 0.000133 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.0002571 | 2 | 0.000129 | 0.870968 | 0.435457 | 3.554557 |
| Within Groups | 0.0026571 | 18 | 0.000148 | | | |
| Total | 0.0029143 | 20 | | | | |

**GRAPHICAL REPRESENTATION**




The Thickness of micro treated fabric (0.39mm) is higher than the untreated fabric (0.38mm). The thickness of the fabric has not been increased considerably after the finish has to be given.

### 4.5.2 TEST FOR MECHANICAL PROPERTIES

#### 4.5.2.1 TENSILE STRENGTH AND ELONGATION – WARP & WEFT

**TABLE- 16**

**FABRIC TENSILE STRENGTH – UNTREATED FABRIC**

| S.NO | WARP DIRECTION | | WEFT DIRECTION | |
|---|---|---|---|---|
| | TENSILE STRENGTH (N/mm^2) | BREAKING FORCE (kgf) | TENSILE STRENGTH (N/mm^2) | BREAKING FORCE (kgf) |
| 1 | 38.80 | 24.42 | 22.38 | 14.83 |
| 2 | 37.52 | 25.05 | 26.86 | 17.80 |
| 3 | 39.13 | 25.12 | 23.46 | 15.55 |
| 4 | 38.54 | 24.53 | 23.06 | 15.29 |
| 5 | 43.57 | 23.54 | 25.72 | 17.05 |
| MEAN | 37.01 | 24.52 | 24.30 | 16.10 |

**TABLE-17**

**TENSILE STRENGTH – PAD TREATED FABRIC**

| S.NO | WARP DIRECTION | | WEFT DIRECTION | |
|---|---|---|---|---|
| | TENSILE STRENGTH | BREAKING FORCE (kgf) | TENSILE STRENGTH | BREAKING FORCE |

| | (N/mm^2) | | (N/mm^2) | (kgf) |
|---|---|---|---|---|
| 1 | 21.11 | 13.99 | 20.37 | 13.50 |
| 2 | 27.88 | 18.48 | 22.90 | 15.58 |
| 3 | 37.96 | 25.16 | 21.76 | 14.43 |
| 4 | 28.04 | 18.58 | 20.30 | 13.45 |
| 5 | 25.57 | 16.95 | 20.02 | 13.27 |
| MEAN | 28.11 | 18.63 | 21.07 | 13.97 |

**TABLE –18**

**TENSILE STRENGTH –MICRO ENCAPSULATION TREATED FABRIC**

| S.NO | WARP DIRECTION | | WEFT DIRECTION | |
|---|---|---|---|---|
| | TENSILE STRENGTH (N/mm^2) | BREAKING FORCE (kgf) | TENSILE STRENGTH (N/mm^2) | BREAKING FORCE (kgf) |
| 1 | 26.07 | 17.28 | 23.83 | 15.80 |
| 2 | 19.55 | 12.96 | 26.86 | 17.80 |
| 3 | 25.51 | 16.91 | 26.55 | 17.60 |
| 4 | 21.71 | 14.44 | 26.89 | 17.83 |
| 5 | 25.49 | 16.89 | 25.10 | 16.64 |
| MEAN | 23.66 | 15.69 | 25.84 | 17.13 |

**TABLE – 19**

**GAIN OR LOSS % OF TENSILE STRENGTH**

| S.NO | SAMPLES | MEAN OF FABRIC THICKNESS | GAIN OR LOSS OVER ORIGINAL | % GAIN OR LOSS |
|---|---|---|---|---|
| 1 | PAD TREATED | 24.59 | -19.77161501 | -44.36161501 |
| 2 | MICRO TREATED | 24.75 | 19.24959217 | -24.75 |

## STATISTICAL ANALYSIS:

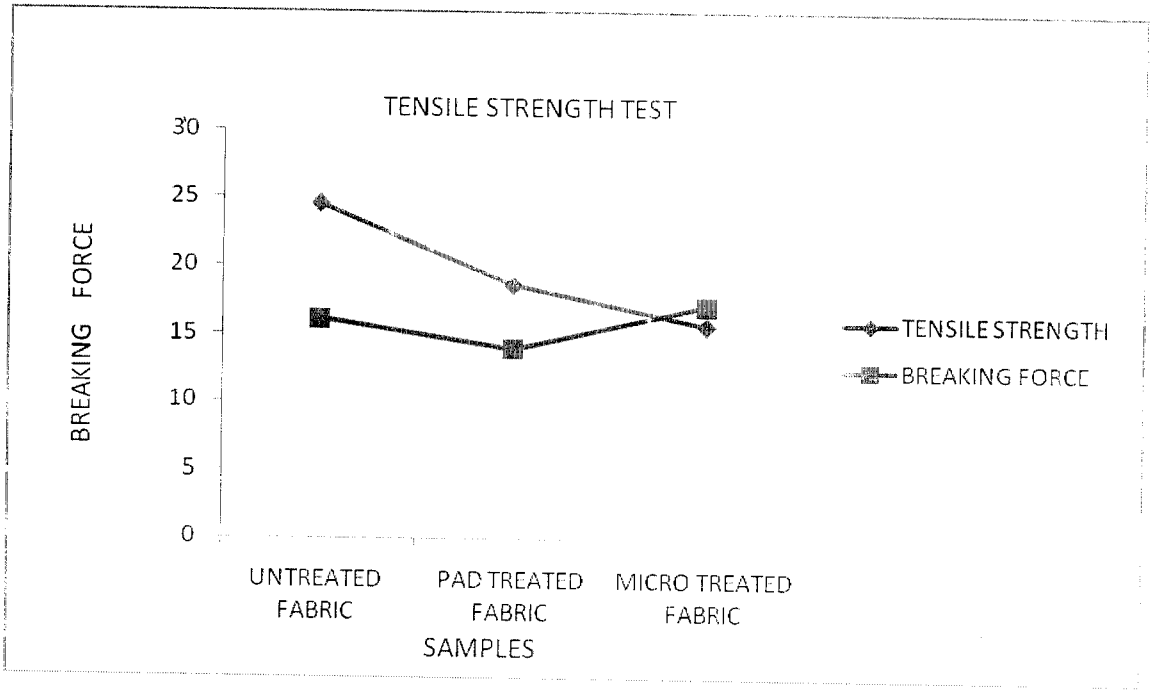
Anova: Two-Factor Without Replication

| *SUMMARY* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| UNTREATED FABRIC | 2 | 50.96 | 25.48 | 53.4578 |
| PAD TREATED FABRIC | 2 | 40.89 | 20.445 | 34.36205 |
| MICRO TREATED FABRIC | 2 | 41.16 | 20.58 | 34.7778 |
| | | | | |
| TENSILE STRENGTH | 3 | 79.99 | 26.66333 | 11.92653 |
| BREAKING FORCE | 3 | 53.02 | 17.67333 | 5.217033 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Rows | 32.91963333 | 2 | 16.45982 | 24.07286 | 0.039884 | 19 |
| Columns | 121.23015 | 1 | 121.2302 | 177.3019 | 0.005593 | 18.51282 |
| Error | 1.3675 | 2 | 0.68375 | | | |
| | | | | | | |
| Total | 155.5172833 | 5 | | | | |

## GRAPHICAL REPRESENTATION:




Tensile strength of the fabric is very important while constructing a functional product. The Tensile strength of the micro treated and pad treated fabric showed a minimum reduction in the tensile strength and minimum increase in the elongation in both warp and weft direction when compared to untreated fabric.

### 4.5.2.2 ABRASION RESISTANCE

**TABLE -20**

**ABRASION RESISTANCE -UNTREATED FABRIC**

| S.NO | INITIAL WEIGHT(gms) | FINAL WEIGHT(gms) | WEIGHT LOSS (%) | ABRASION RESISTANCE (%) |
|---|---|---|---|---|
| 1 | 0.19 | 0.18 | 5.2 | 94.8 |
| 2 | 0.19 | 0.18 | 5.2 | 94.8 |
| 3 | 0.20 | 0.18 | 10 | 90.0 |
| 4 | 0.18 | 0.17 | 5.5 | 94.5 |
| 5 | 0.19 | 0.18 | 5.2 | 94.8 |
| 6 | 0.20 | 0.19 | 5.0 | 95.0 |
| 7 | 0.19 | 0.18 | 5.2 | 94.8 |
| MEAN | 0.19 | 0.18 | 5.9 | 94.8 |

**TABLE –21**

**ABRASION RESISTANCE –PAD TREATED FABRIC**

| S.NO | INITIAL WEIGHT(gms) | FINAL WEIGHT(gms) | WEIGHT LOSS (%) | ABRASION RESISTANCE (%) |
|---|---|---|---|---|
| 1 | 0.17 | 0.16 | 5.8 | 94.2 |
| 2 | 0.18 | 0.17 | 5.5 | 94.5 |
| 3 | 0.15 | 0.14 | 6.6 | 93.4 |
| 4 | 0.17 | 0.16 | 5.8 | 94.2 |
| 5 | 0.16 | 0.15 | 5.5 | 93.7 |
| 6 | 0.15 | 0.14 | 6.6 | 93.4 |
| 7 | 0.18 | 0.17 | 5.5 | 94.5 |
| MEAN | 0.16 | 0.15 | 5.9 | 93.9 |

**TABLE –22**

**ABRASION RESISTANCE –MICRO ENCAPSULATION TREATED FABRIC**

| S.NO | INITIAL WEIGHT(gms) | FINAL WEIGHT(gms) | WEIGHT LOSS (%) | ABRASION RESISTANCE (%) |
|---|---|---|---|---|
| 1 | 0.19 | 0.18 | 5.2 | 94.8 |
| 2 | 0.17 | 0.16 | 5.8 | 94.2 |
| 3 | 0.20 | 0.19 | 5.0 | 95.0 |
| 4 | 0.18 | 0.17 | 5.5 | 94.5 |
| 5 | 0.19 | 0.18 | 5.2 | 94.8 |
| 6 | 0.19 | 0.18 | 5.2 | 94.8 |
| 7 | 0.18 | 0.17 | 5.5 | 94.5 |

| | | | | |
|---|---|---|---|---|
| MEAN | 0.18 | 0.17 | 5.34 | 94.6 |

**TABLE-23**

**GAIN OR LOSS % FOR ABRASION RESISTANCE**

| S.NO | SAMPLES | MEAN OF FABRIC THICKNESS | GAIN OR LOSS OVER ORIGINAL | % GAIN OR LOSS |
|---|---|---|---|---|
| 1 | PAD TREATED | 93.9 | -0.949367089 | -94.84936709 |
| 2 | MICRO TREATED | 94.6 | 0.210970464 | -94.6 |

**STATISTICAL ANALYSIS:**

Anova: Single Factor

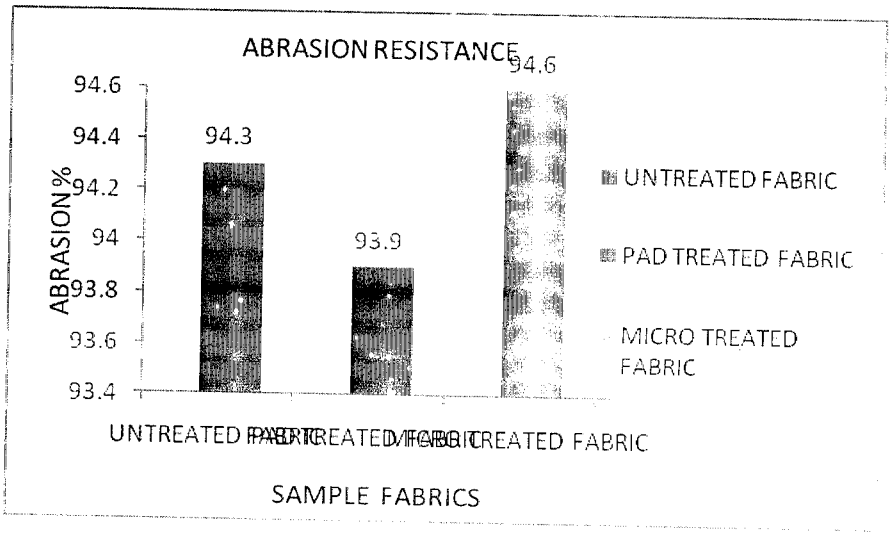
SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| UNTREATED FABRIC | 7 | 658.7 | 94.1 | 3.29 |
| PAD TREATED FABRIC | 7 | 657.9 | 93.98571 | 0.231429 |
| MICRO TREATED FABRIC | 7 | 662.6 | 94.65714 | 0.072857 |

ANOVA

| *Source of Variation* | *SS* | *Df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 1.8066667 | 2 | 0.903333 | 0.753975 | 0.484784 | 3.554557 |
| Within Groups | 21.565714 | 18 | 1.198095 | | | |
| Total | 23.372381 | 20 | | | | |

## GRAPHICAL REPRESENTATION:




The abrasion resistance has not reduced even after the finish has been given to the fabric in mocro encapsulation method but pad ddry cure method the abrasion resistance slightly reduced when compared to untreated sample. From the statiatical analysis it was concluded that the F value shows the significance difference in the abrasion resistance.

## 4.5.3 TEST FOR COMFORT PROPERTIES

### 4.5.3.1 STIFFNESS TEST

**TABLE –24**

**FABRIC STIFFNESS - UNTREATED FABRIC**

| S.NO | WARP DIRECTION | | WEFT DIRECTION | |
|---|---|---|---|---|
| | BENDING LENGTH(C) in cm | FLEXURAL RIGIDITY(G) in mg.cm | BENDING LENGTH(C) in cm | FLEXURAL RIGIDITY(G) in mg.cm |
| 1 | 2.75 | 7486.80 | 2.40 | 5391.36 |

| | | | | |
|---|---|---|---|---|
| 2 | 2.50 | 5625.00 | 2.10 | 3611.79 |
| 3 | 2.10 | 3333.96 | 2.45 | 5735.38 |
| 4 | 2.35 | 4672.03 | 2.20 | 4152.72 |
| 5 | 2.80 | 7902.72 | 2.45 | 5735.38 |
| 6 | 2.75 | 7486.80 | 2.30 | 4745.13 |
| 7 | 2.80 | 7902.72 | 2.50 | 6093.75 |
| MEAN | 2.56 | 6219.38 | 2.30 | 4797.51 |

BENDING MODULUS of the untreated fabric = 6.88 kg/cm2

**TABLE –25**

**FABRIC STIFFNESS – PADDING TREATED FABRIC**

| S.NO | WARP DIRECTION | | WEFT DIRECTION | |
|---|---|---|---|---|
| | BENDING LENGTH(C) in cm | FLEXURAL RIGIDITY(G) in mg.cm | BENDING LENGTH(C) in cm | FLEXURAL RIGIDITY(G) in mg.cm |
| 1 | 2.10 | 3333.96 | 2.30 | 5077.35 |
| 2 | 2.50 | 6344.30 | 2.10 | 3333.96 |
| 3 | 2.60 | 5800.08 | 2.50 | 6344.30 |
| 4 | 2.75 | 7486.80 | 2.45 | 4745.13 |
| 5 | 2.60 | 5800.08 | 2.10 | 3333.96 |
| 6 | 2.10 | 3333.96 | 2.30 | 5077.35 |
| 7 | 2.50 | 6344.30 | 2.10 | 3333.96 |
| MEAN | 2.45 | 5491.92 | 2.26 | 4463.71 |

BENDING MODULUS of the pad treated fabric = 7.24 kg/cm2

**TABLE –26**

**FABRIC STIFFNESS –MICROENCAPSULATION TREATED FABRIC**

| S.NO | WARP DIRECTION | | WEFT DIRECTION | |
|---|---|---|---|---|
| | BENDING LENGTH(C) in cm | FLEXURAL RIGIDITY(G) in mg.cm | BENDING LENGTH(C) in cm | FLEXURAL RIGIDITY(G) in mg.cm |
| 1 | 2.95 | 8985.30 | 2.35 | 4801.80 |
| 2 | 2.50 | 8198.27 | 2.40 | 5114.88 |
| 3 | 2.85 | 8102.19 | 2.50 | 5781.25 |
| 4 | 2.95 | 8985.30 | 2.30 | 4501.79 |
| 5 | 2.90 | 8536.15 | 2.40 | 5114.88 |

| | | | | |
|---|---|---|---|---|
| 6 | 2.90 | 8536.15 | 2.50 | 5781.25 |
| 7 | 3.00 | 9450.00 | 2.30 | 4501.79 |
| MEAN | 2.86 | 8684.76 | 2.39 | 5085.37 |

BENDING MODULUS of the micro treated fabric = 8.56kg/cm2

**TABLE-27**

**GAIN OR LOSS % OF FABRIC STIFFNESS**

| S.NO | SAMPLES | MEAN OF FABRIC THICKNESS | GAIN OR LOSS OVER ORIGINAL | % GAIN OR LOSS |
|---|---|---|---|---|
| 1 | PAD TREATED | 2.35 | -3.29218107 | -5.64218107 |
| 2 | MICRO TREATED | 2.6 | -6.995884774 | -2.5 |

**STATISTICAL ANALYSIS:**

Anova: Single Factor

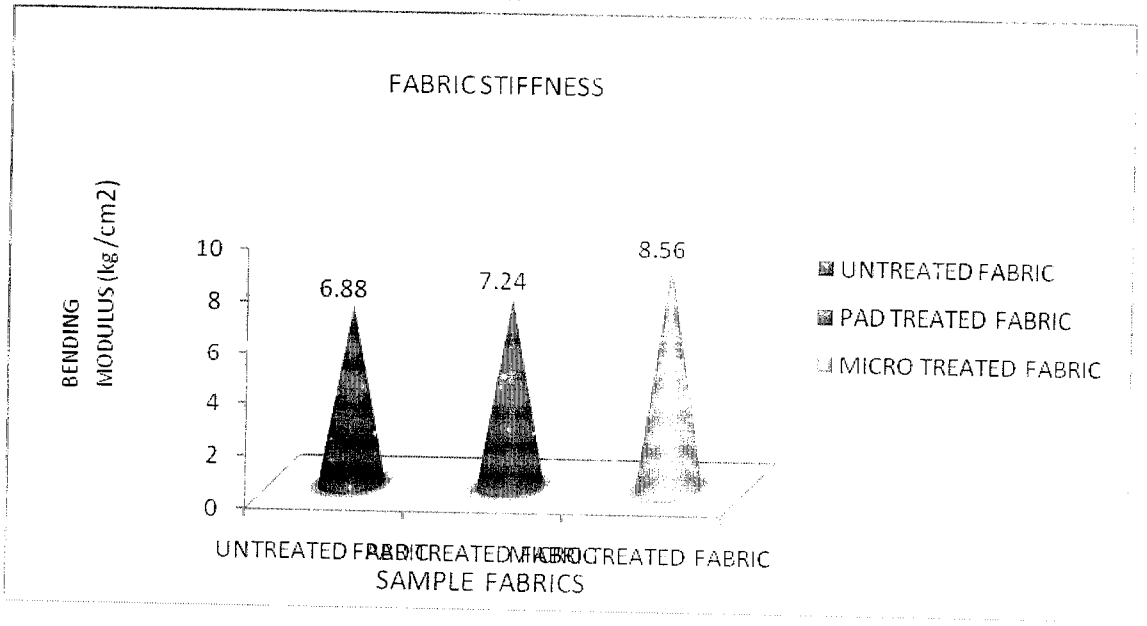
SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| UNTREATED FABRIC | 7 | 39937.77 | 5705.396 | 1307098 |
| PAD TREATED FABRIC | 7 | 34844.75 | 4977.821 | 648787.3 |
| MICRO TREATED FABRIC | 7 | 48195.5 | 6885.071 | 27031.63 |

ANOVA

| *Source of Variation* | *SS* | *Df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 12970079 | 2 | 6485040 | 9.811361 | 0.001313 | 3.554557 |
| Within Groups | 11897504 | 18 | 660972.5 | | | |
| Total | 24867584 | 20 | | | | |

**GRAPHICAL REPRESENTATION:**




The stiffness of the fabric is measured by knowing the bending modulus of the fabric. The Stiffness of the pad and micro treated fabrics (7.24Kg/cm^2, 8.56Kg/cm^2) showed higher in stiffness when compared to untreated fabric (6.88Kg/cm^2).The fabric stiffness has not reduced even after the finish has been given to the fabric.

### 4.5.3.2 DRAPE

**TABLE –28**

**FABRIC DRAPE – UNTREATED FABRIC**

| S.NO | W s (gms) | Wd (gms) | WD (gms) | D (%) |
|---|---|---|---|---|
| 1 | 3.45 | 1.91 | 3.67 | 0.875 |
| 2 | 3.35 | 1.91 | 3.67 | 0.818 |
| 3 | 3.25 | 1.91 | 3.67 | 0.761 |
| 4 | 3.15 | 1.91 | 3.67 | 0.704 |
| 5 | 3.05 | 1.91 | 3.67 | 0.647 |
| 6 | 3.00 | 1.91 | 3.67 | 0.619 |
| 7 | 3.05 | 1.91 | 3.67 | 0.647 |
| MEAN | 3.18 | 1.91 | 3.67 | 0.724 |

## TABLE –29

## FABRIC DRAPE –PAD TREATED FABRIC

| S.NO | Ws (gms) | Wd (gms) | WD (gms) | D (%) |
|---|---|---|---|---|
| 1 | 3.17 | 1.91 | 3.67 | 0.71 |
| 2 | 2.80 | 1.91 | 3.67 | 0.50 |
| 3 | 3.20 | 1.91 | 3.67 | 0.73 |
| 4 | 3.00 | 1.91 | 3.67 | 0.61 |
| 5 | 2.80 | 1.91 | 3.67 | 0.50 |
| 6 | 2.90 | 1.91 | 3.67 | 0.56 |
| 7 | 3.00 | 1.91 | 3.67 | 0.61 |
| MEAN | 2.96 | 1.91 | 3.67 | 0.60 |

## TABLE –30

## FABRIC DRAPE – MICRO ENCAPSULATION TREATED FABRIC

| S.NO | Ws (gms) | Wd (gms) | Wd (gms) | D (%) |
|---|---|---|---|---|
| 1 | 3.80 | 1.91 | 3.67 | 1.07 |
| 2 | 3.50 | 1.91 | 3.67 | 0.90 |
| 3 | 3.60 | 1.91 | 3.67 | 0.96 |
| 4 | 3.70 | 1.91 | 3.67 | 1.01 |
| 5 | 3.40 | 1.91 | 3.67 | 0.84 |
| 6 | 3.50 | 1.91 | 3.67 | 0.90 |
| 7 | 3.70 | 1.91 | 3.67 | 1.01 |
| MEAN | 3.60 | 1.91 | 3.67 | 0.96 |

## TABLE-31

## GAIN OR LOSS OF FABRIC DRAPE

| S.NO | SAMPLES | MEAN OF FABRIC THICKNESS | GAIN OR LOSS OVER ORIGINAL | % GAIN OR LOSS |
|---|---|---|---|---|
| 1 | PAD TREATED | 0.60 | -17.12707182 | -17.72707182 |
| 2 | MICRO TREATED | 0.96 | -32.59668508 | -0.96 |

## STATISTICAL ANALYSIS:

Anova: Single Factor

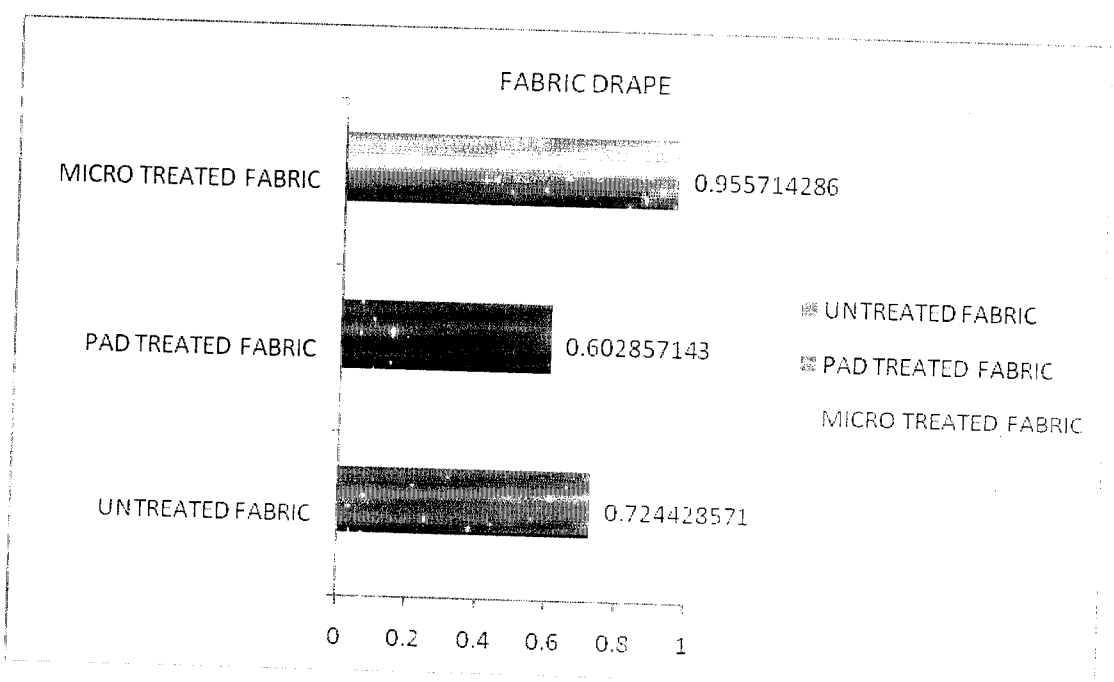
SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| UNTREATED FABRIC | 7 | 5.071 | 0.724429 | 0.009381 |
| PAD TREATED FABRIC | 7 | 4.22 | 0.602857 | 0.008457 |
| MICRO TREATED FABRIC | 7 | 6.69 | 0.955714 | 0.006429 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.449822 | 2 | 0.224911 | 27.80455 | 3.13E-06 | 3.554557 |
| Within Groups | 0.145602 | 18 | 0.008089 | | | |
| Total | 0.595424 | 20 | | | | |

## GRAPHICAL REPRESENTATION:



Drape co-efficient of micro treated fabrics shows higher results when compared to untreated fabric. The pad treated fabric showed lower drape co-efficient results compared to un treated sample, the statistical analysis also shows the same difference in signifance

### 4.5.3.3 AIR PERMEABILITY TEST

**TABLE –32**

**AIR PERMEABILITY - UNTREATED, PAD MICRO TREATED FABRICS**

| S.NO | UNTREATED FABRIC(lph) | AIR PERMEABILITY (cm3/sec) | PAD TREATED (lph) | AIR PERMEABILITY (cm3/sec) | MICRO TREATED 690(lph) | AIR PERMEABILITY (cm3/sec) |
|---|---|---|---|---|---|---|
| 1 | 690 | 0.0019 | 760 | 0.002 | 690 | 0.0019 |
| 2 | 690 | 0.0019 | 700 | 0.019 | 700 | 0.0190 |
| 3 | 690 | 0.0019 | 690 | 0.0019 | 690 | 0.0019 |
| 4 | 700 | 0.0190 | 690 | 0.0019 | 700 | 0.0190 |
| 5 | 700 | 0.0190 | 700 | 0.019 | 690 | 0.0019 |
| 6 | 690 | 0.0019 | 690 | 0.0019 | 690 | 0.0019 |
| 7 | 690 | 0.0019 | 690 | 0.0019 | 700 | 0.0190 |
| MEAN | 692.8 | 0.0067 | 702.85 | 0.0068 | 694.28 | 0.0092 |

**TABLE-33**

**GAIN OR LOSS OF AIR PERMEABILITY**

| S.NO | SAMPLES | MEAN OF FABRIC THICKNESS | GAIN OR LOSS OVER ORIGINAL | % GAIN OR LOSS |
|---|---|---|---|---|
| 1 | PAD TREATED | 0.0068 | 1.492537313 | 1.485737313 |
| 2 | MICRO TREATED | 0.0092 | -37.31343284 | -0.0092 |

## STATISTICAL ANALYSIS:

Anova: Single Factor

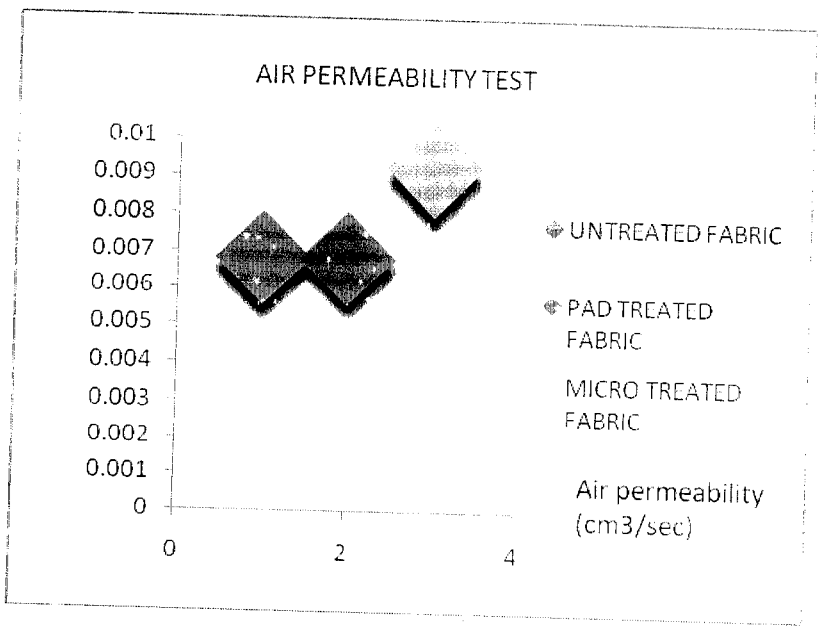
SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| UNTREATED FABRIC | 7 | 0.0475 | 0.006786 | 6.96E-05 |
| PAD TREATED FABRIC | 7 | 0.0476 | 0.0068 | 6.95E-05 |
| MICRO TREATED FABRIC | 7 | 0.0646 | 0.009229 | 8.35E-05 |

ANOVA

| *Source of Variation* | *SS* | *Df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 2.769E-05 | 2 | 1.38E-05 | 0.186545 | 0.831405 | 3.554557 |
| Within Groups | 0.0013358 | 18 | 7.42E-05 | | | |
| Total | 0.0013634 | 20 | | | | |

## GRAPHICAL REPRESENTATION:




The air permeability of the pad and micro treated fabric is higher when compared to untreated fabric.

### 4.6.4 TEST FOR ABSORBENCY

#### 4.6.4.1 WICKING

**TABLE –34**

**WICKING TEST – UNTREATED, PAD TREATED, MICRO TREATED FABRICS**

| TIME (mins) | HEIGHT (cm) | | |
|---|---|---|---|
| | UN TREATED FABRIC(water) | PAD TREATED (water) | MICRO TREATED (water) |
| 5 | 3.0 | 2.9 | 3.0 |
| 10 | 4.5 | 3.0 | 3.6 |
| 15 | 4.9 | 3.8 | 3.9 |
| 20 | 5.2 | 4.0 | 4.2 |
| 25 | 5.4 | 4.0 | 4.0 |
| 30 | 5.5 | 4.4 | 4.5 |

**STATISTICAL ANALYSIS**:

Anova: Single Factor

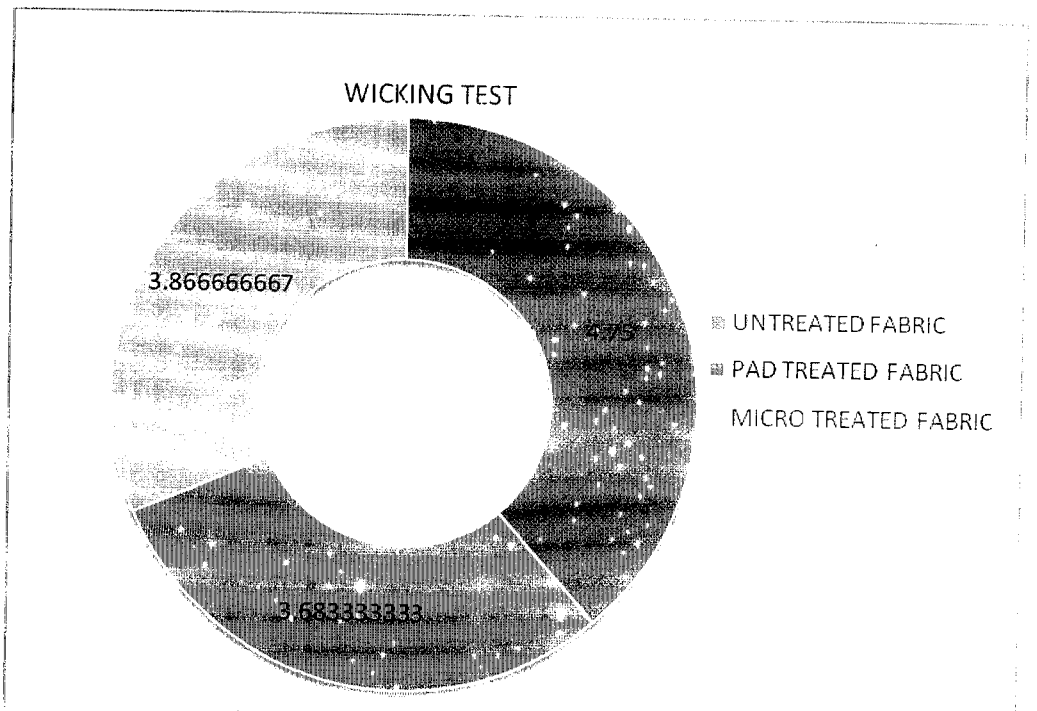
SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| UNTREATED FABRIC | 6 | 28.5 | 4.75 | 0.867 |
| PAD TREATED FABRIC | 6 | 22.1 | 3.683333 | 0.361667 |
| MICRO TREATED FABRIC | 6 | 23.2 | 3.866667 | 0.270667 |

ANOVA

| *Source of Variation* | *SS* | *Df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 3.9033333 | 2 | 1.951667 | 3.905069 | 0.043125 | 3.68232 |
| Within Groups | 7.4966667 | 15 | 0.499778 | | | |
| Total | 11.4 | 17 | | | | |

## GRAPHICAL REPRESENTATION:




The absorbency of the fabrics pad treated and micro treated has reduced compared to untreated fabric.

### 4.7 SEM STUDY

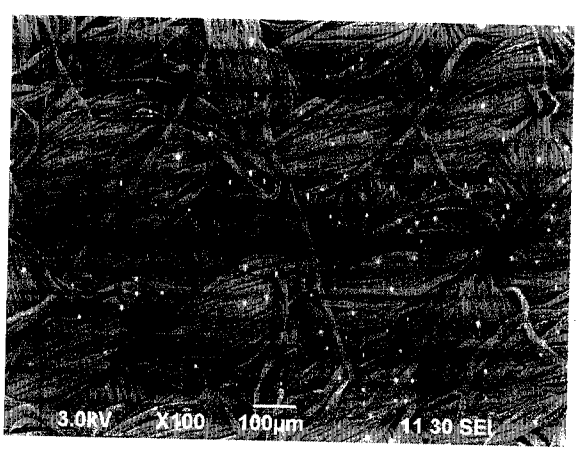



plate1

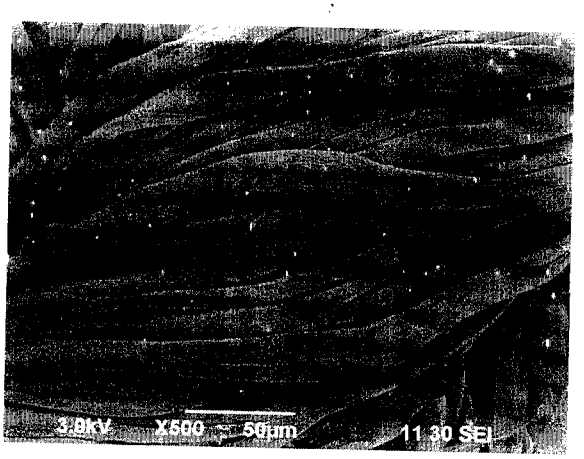



plate 2

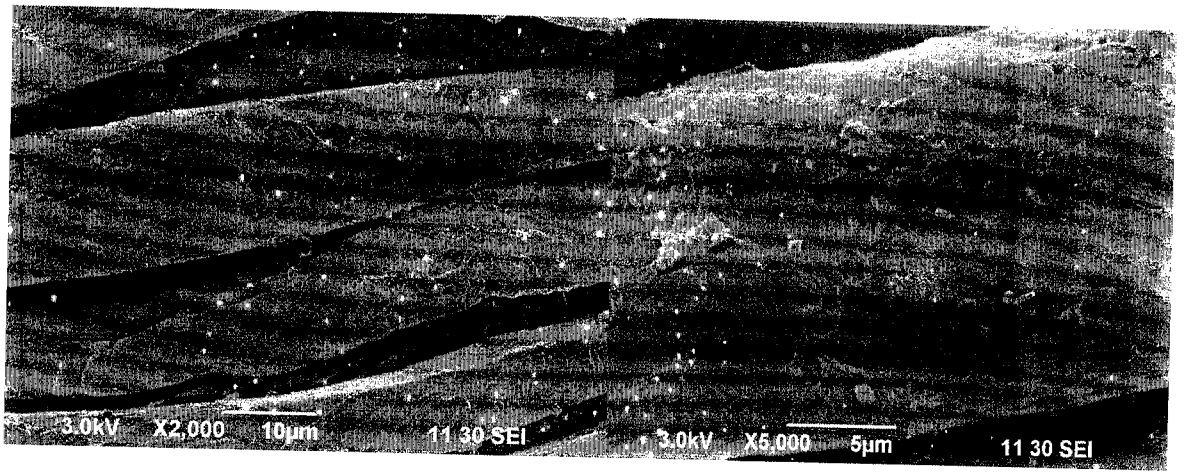
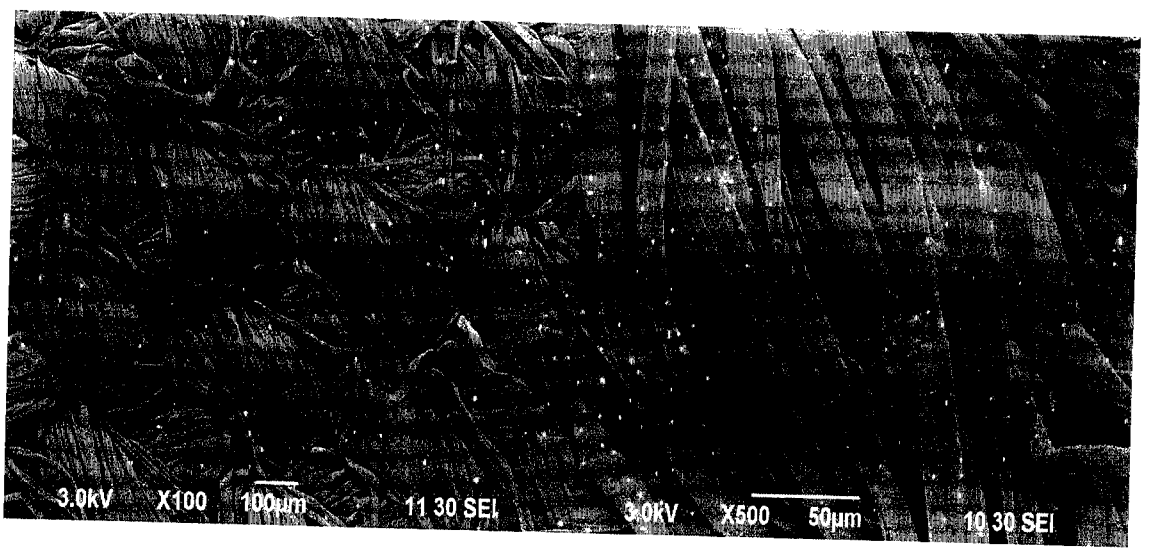



plate1

plate 2




The magnification levels for green tea pad dry finished samples are X100, X500, X1000 and X5000 (Plates – a to d). Similarly the magnification levels for green tea micro encapsulation finished samples are X100, X500, X2500, X5000 (Plates – 1 to 4).

The surface of green tea sample shows the open weave structure with few protruding fibres and minute capsule formation. In the finished sample, the maximum deposition of herbal solution is observed by the reduced pore size in the weave structure. The X5000 resolution in micro encapsulation finished sample in the shows a reduced pore size in the fabric surface which is the result of uniform deposition of herbal solutions. The micro finished fabric sample absorbed maximum quantity of herbal solution than the pad dry finished fabric. Hence due to the high

penetration of herbal solution and increase in the size of the capsules, it enhances the durability of the finish.

### 4.8 WEAR STUDY

The untreated chrysanthemum pad and micro finished night coat was given to the men at Indian ayurvedic hospital for 7 days in 10 hrs time duration, the qustionare was given to the wearer and the comments of the wearer was also collected and consolidated, the developed products were analysed by the doctor and the doctors report was also enclosed in the appendix.

### 4.9 WASH DURABILITY TEST

**TABLE –35**

**WASH DURABILITY – PAD TREATED FABRIC**

| S.NO | S.AURIEUS | | E.COLI | |
|---|---|---|---|---|
| | NO. OF WASHES | ZONE OF INHIBITION (mm) | NO. OF WASHES | ZONE OF INHIBITION (mm) |
| 1 | 1 | 18 | 1 | 17 |
| 2 | 3 | 15 | 3 | 15 |
| 3 | 5 | 13 | 5 | 12 |
| 4 | 10 | 11 | 10 | 9 |
| 5 | 15 | 9 | 15 | 8 |
| 6 | 20 | 7 | 20 | 5 |
| 7 | 25 | 5 | 25 | 3 |
| 8 | 30 | 3 | 30 | 1 |

**STATISTICAL ANALYSIS:**

F-Test Two-Sample for Variances

| | *STAPHYLOCOCCUS* | *E.COLI* |
|---|---|---|
| Mean | 14.125 | 13.875 |
| Variance | 4.410714286 | 4.125 |
| Observations | 8 | 8 |
| df | 7 | 7 |
| F | 1.069264069 | |
| P(F<=f) one-tail | 0.465936702 | |
| F Critical one-tail | 3.78704354 | |

GRAPHICAL REPRESENTATION:

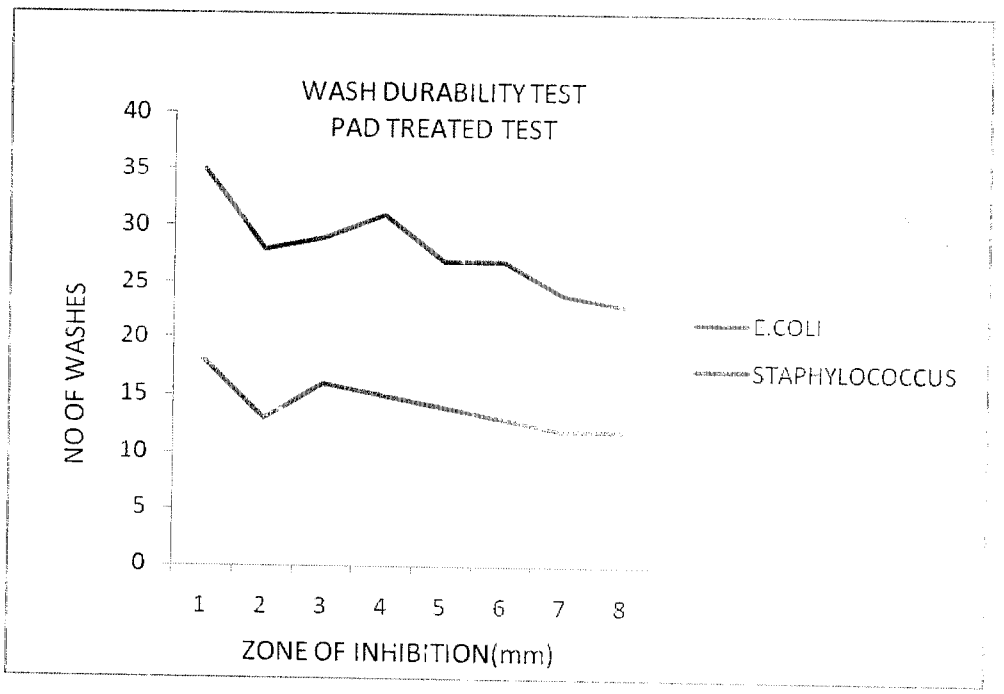



**TABLE-36**

**WASH DURABILITY – MICRO ENCAPSULATION TREATED**

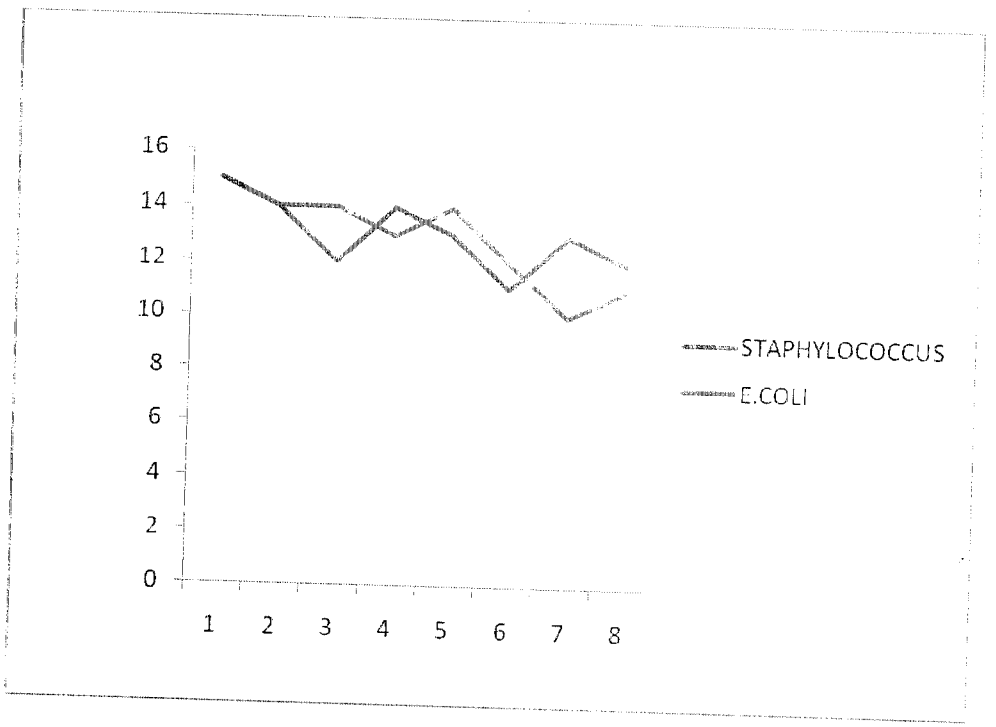
| S.NO | S.AURIEUS | | E.COLI | |
|---|---|---|---|---|
| | NO. OF WASHES | ZONE OF INHIBITION (mm) | NO. OF WASHES | ZONE OF INHIBITION (mm) |
| 1 | 1 | 15 | 1 | 15 |
| 2 | 3 | 14 | 3 | 14 |
| 3 | 5 | 13 | 5 | 13 |
| 4 | 10 | 12 | 10 | 12 |
| 5 | 15 | 10 | 15 | 10 |
| 6 | 20 | 8 | 20 | 9 |
| 7 | 25 | 6 | 25 | 7 |
| 8 | 30 | 4 | 30 | 6 |

**STATISTICAL ANALYSIS:**

F-Test Two-Sample for Variances

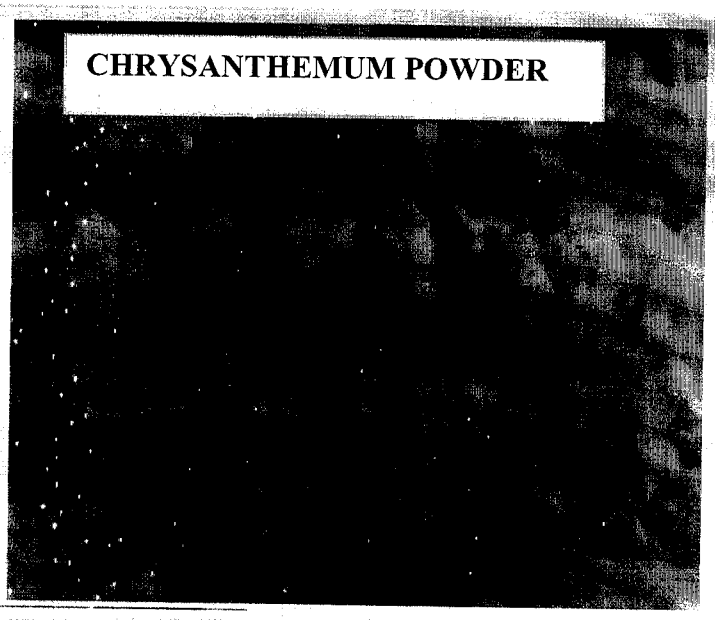
| | *STAPHYLOCOCCUS* | *E.COLI* |
|---|---|---|
| Mean | 12.875 | 13 |
| Variance | 2.982142857 | 1.714285714 |
| Observations | 8 | 8 |
| df | 7 | 7 |
| F | 1.739583333 | |
| P(F<=f) one-tail | 0.241176464 | |
| F Critical one-tail | 3.78704354 | |

GRAPHICAL REPRESENTATION:

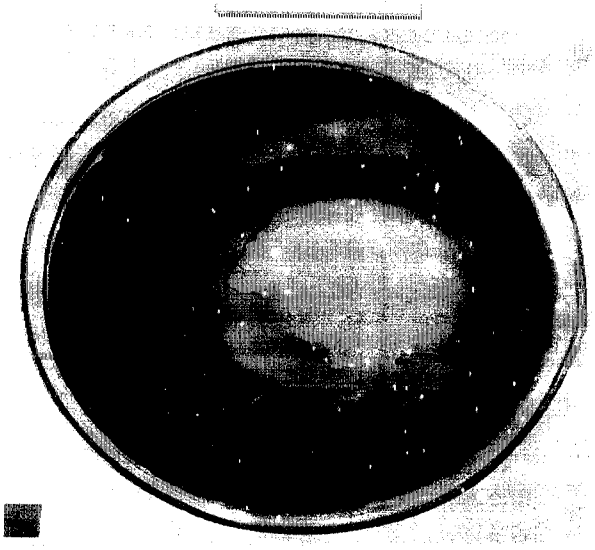



The application of herbal extract on fabrics lasts upto 12 washes in pad treated and 23 washes in micro treated fabrics against Staphylococcus aureus and E.coli. From the wash durability test results showed the maximum durability in the micro finished samples because the herbal solutions were deposited in a capsuel form and also release the finish in a slow manner.So the micro encapsulation process increase the durability of the product.

## PLATE-1


EXTRACT



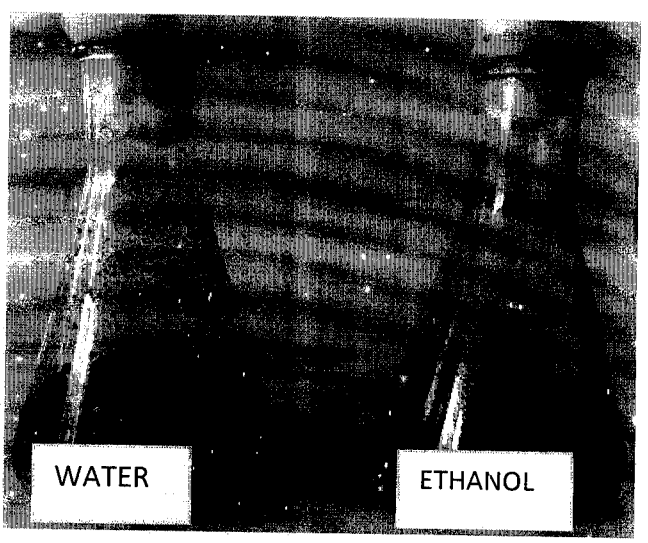
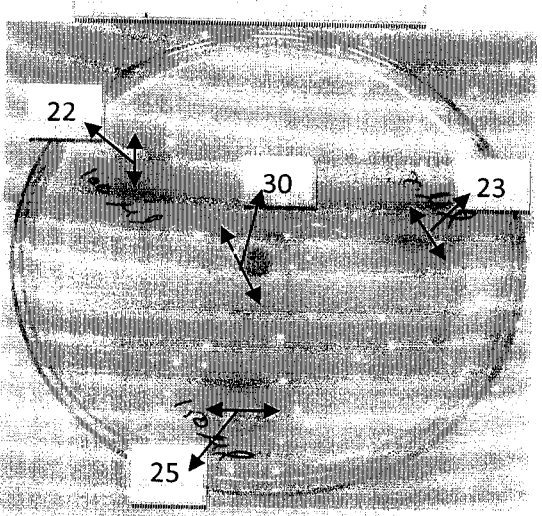


Plate-2

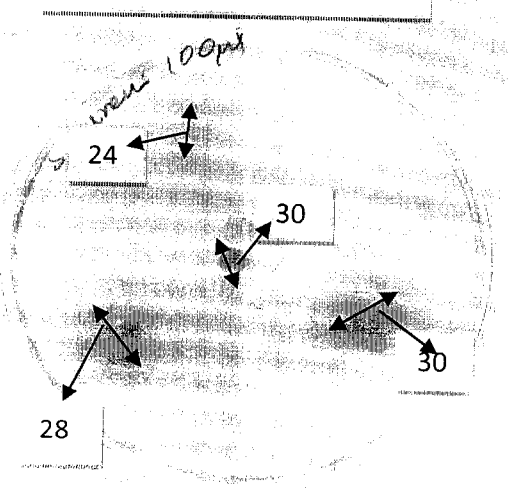
OPTIMISATION OF SOLVENTS

CHRYSANTHEMUM-STAPHLOCOCCUS

ETHONAL

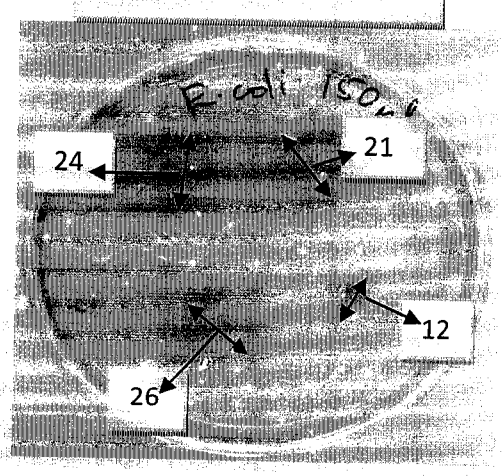



WATER




CHRYSANTHEMUM-ECOLI

ETHONAL

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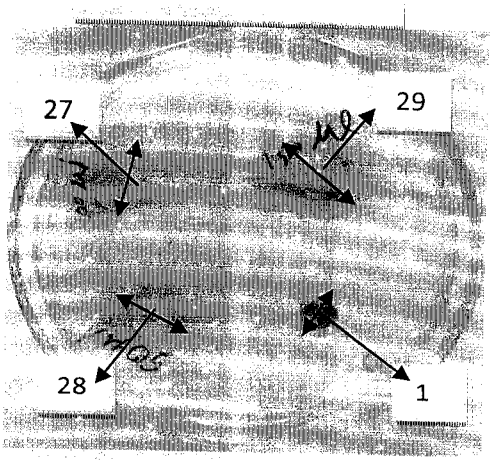
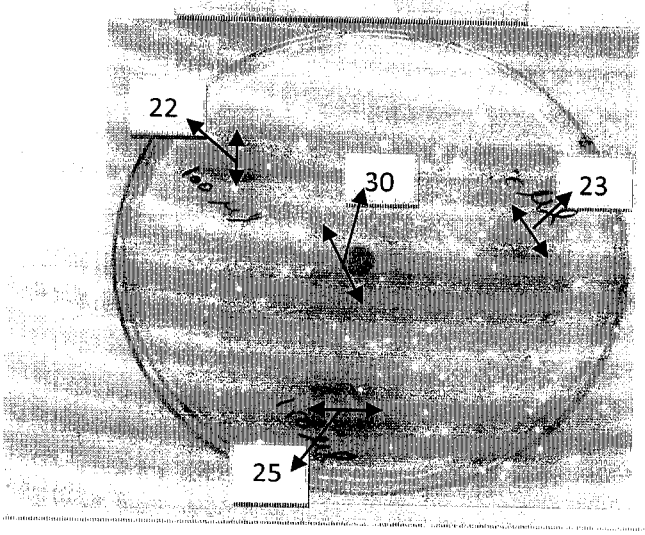


PLATE-3

PLATE- CHRYSANTHEMUM

CHRYSANTHEMUM-STAPHLOCOCCUS

ETHONAL

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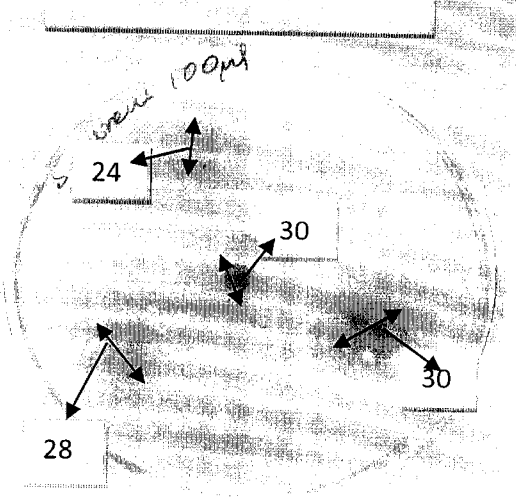
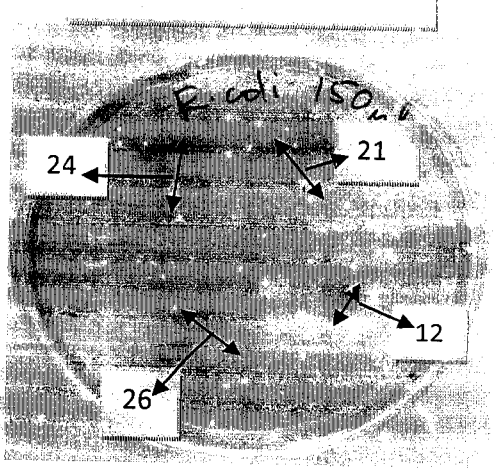



CHRYSANTHEMUM-ECOLI

ETHONAL

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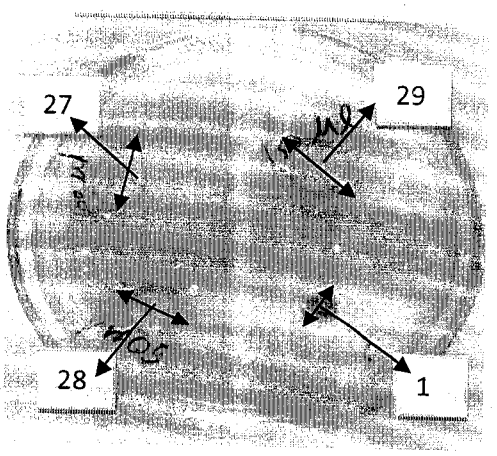
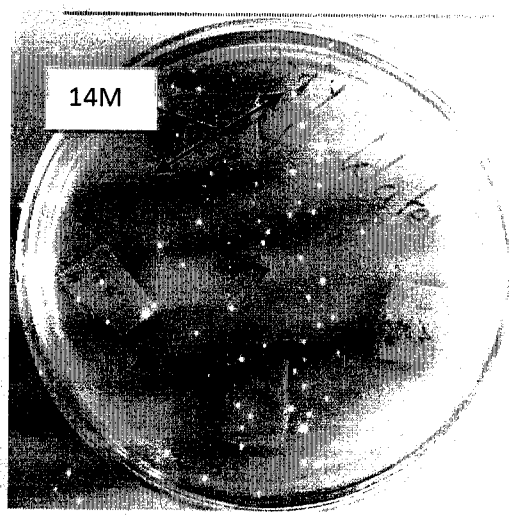


PLATE-4

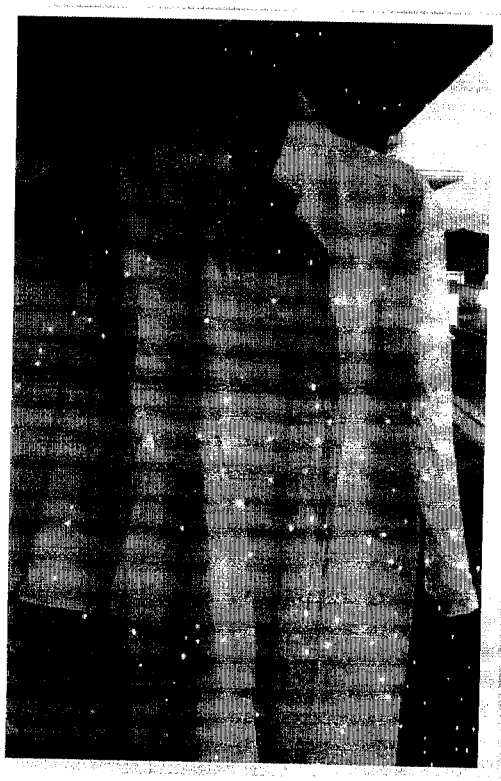
OPTIMATION OF PROCESS CONDITIONS- BRST ZONE

WATER -90MINS-60$^0$C- 14mm



## PLATE-5

CONSTRUCTED PROCEDUCTS



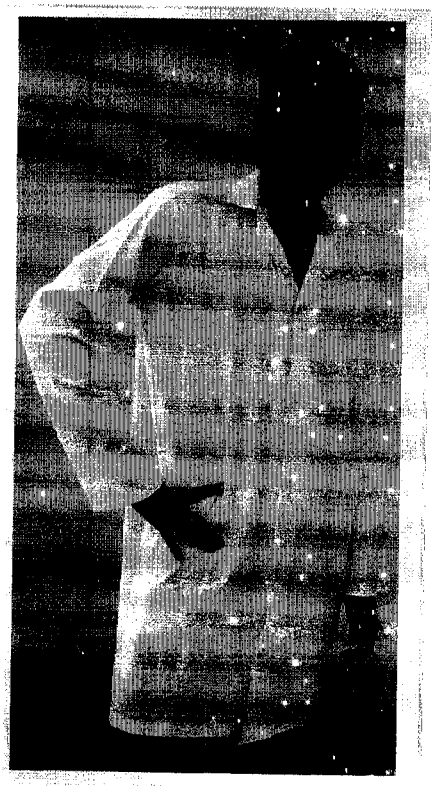
UNTREATED

PAD TREATED

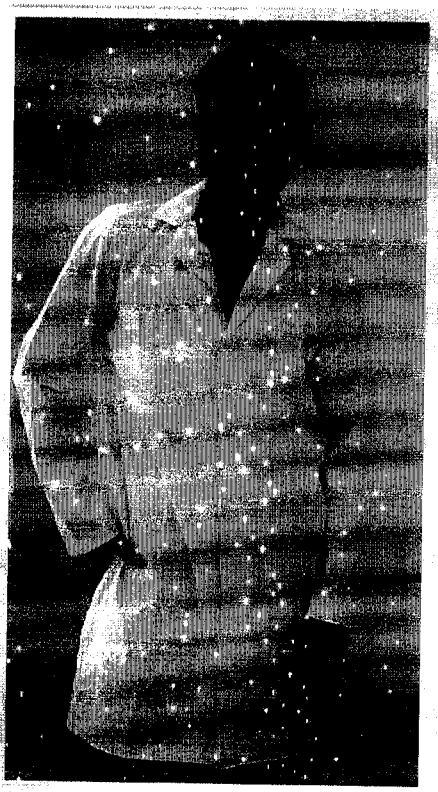
MICRO TREATED

## PLATE-6

## WEAR STUDY



UNTREATED



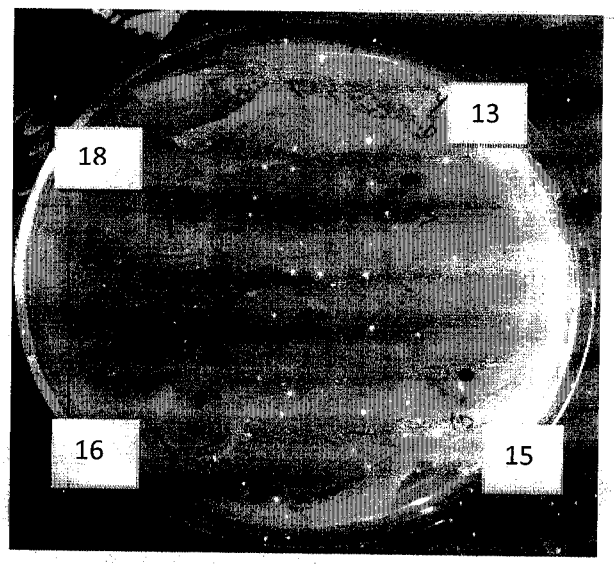
PAD TREATED

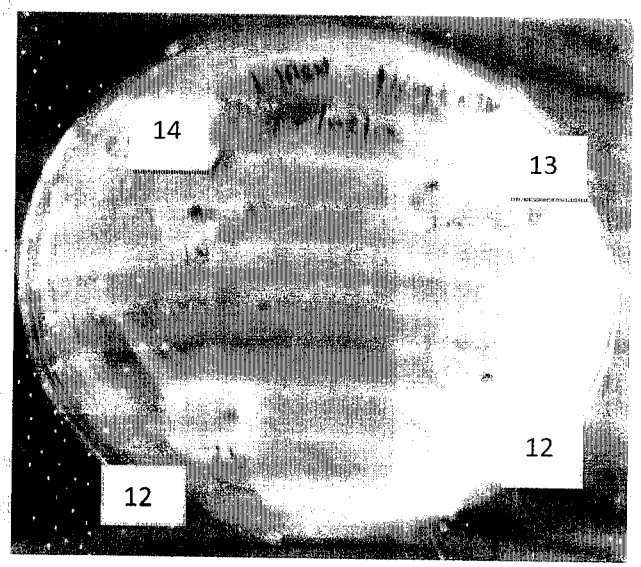
MICRO TREATED

# PLATE-7

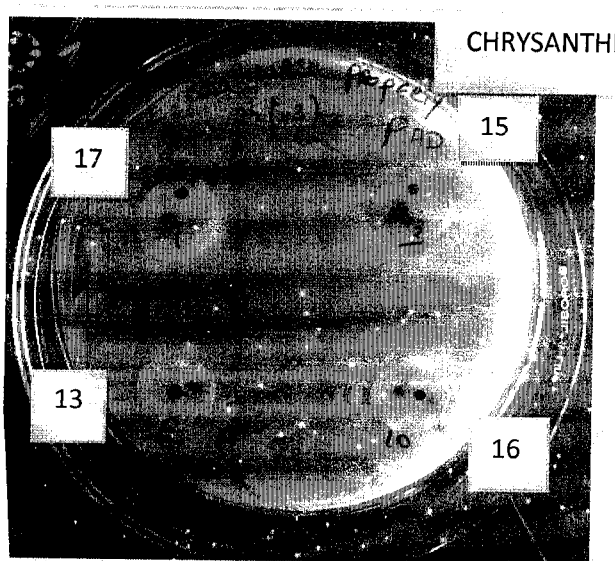
CHRYSANTHEMUM –PADDING METHOD

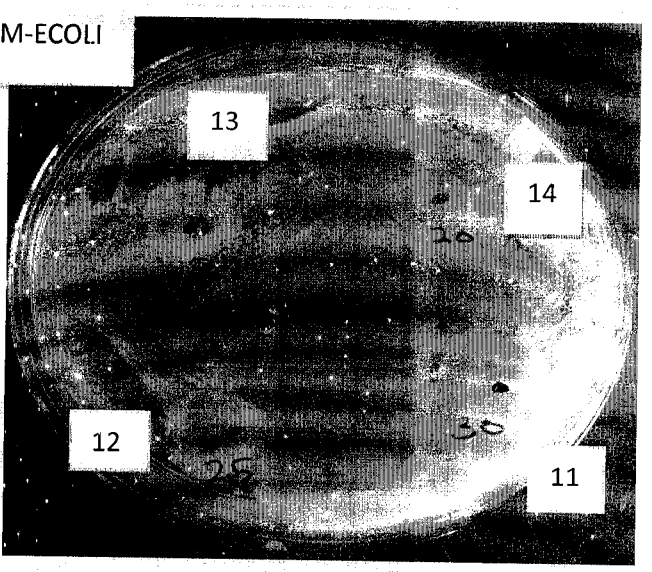
CHRYSANTHEMUM-STAPHLOCOCCUS AUREUS




CHRYSANTHEMUM-ECOLI

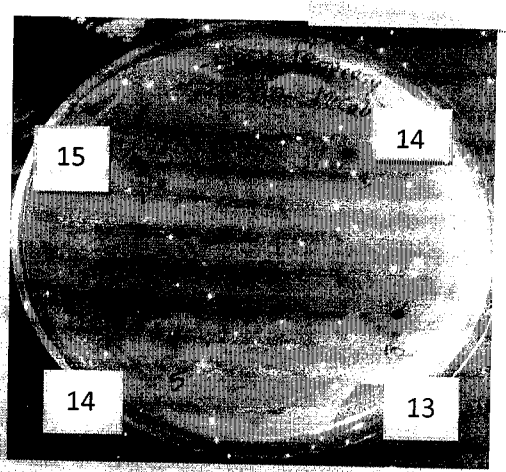


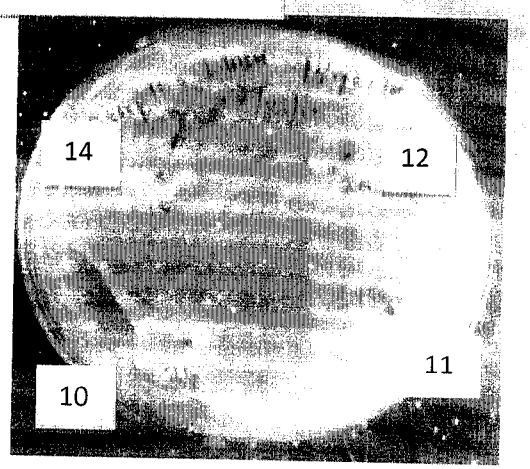



# PLATE -8

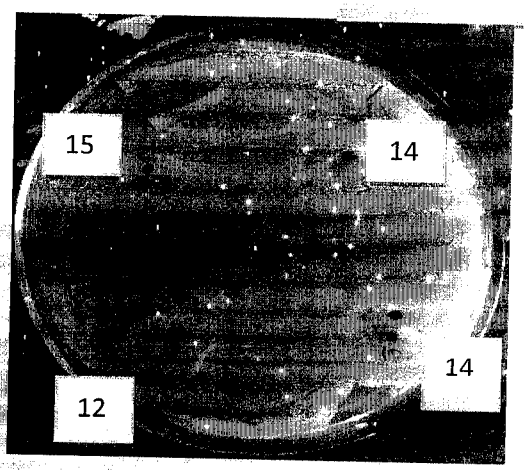
CHRYSANTHEMUM –MICRO ENCAPSULATION METHOD

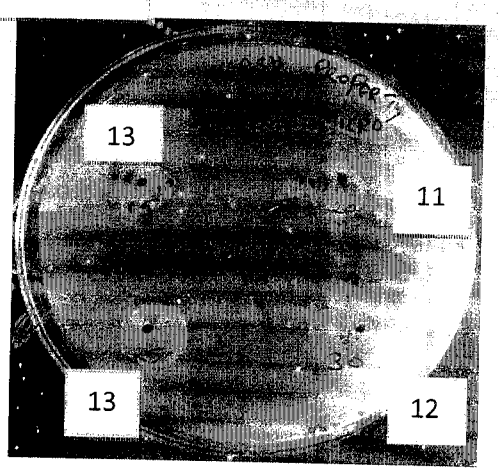
CHRYSANTHEMUM-STAPHLOCOCCUS AUREUS



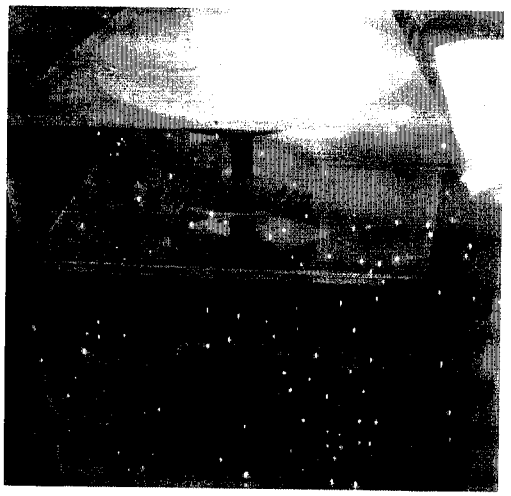

CHRYSANTHEMUM-ECOLI

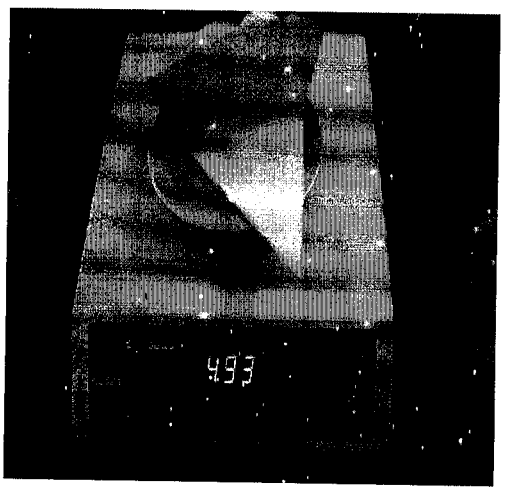


# PLATE-9

## MACHINERIES USED FOR FABRIC TESTING






# CONCLUSION

## CONCLUSION:

Effects Mosquito bite and bacterial has been considered to be the major cause for humanity since they spread several types of deseases like viral diseases, such as yellow fever, dengue fever and Chikungunya. These led to the development of various mosquito repellent and antibacterial finishing technologies. Today world is moving towards the era of eco-friendly textiles. There is the vast natural resource available for imparting the eco-friendly finishes like mosquito repellent and antibacterial finishes. This project work is on imparting the mosquito repellency and antibacterial finish on the cotton fabric with the effective natural herb to produce the cotton night coat. The herb used for the both mosquito repellent and antibacterial finish is chrysanthemum. The pyto chemical pyrethrum in the chrysanthemum gives the mosquito repellent property to the treated fabric. The extract is extracted from dry and fresh method with two different solvent ethanol and distilled water. The distilled water is found as the best solvent and it is selected for the further process. The process conditions are optimized with three different temperatures, three different concentrations, three different times and two MLR based on orthogonal design table. The fabric is treated with the pad dry cure and micro encapsulation method. The mosquito repellency is tested with the U.S. Patent 5,198,287 and USDA Laboratory method which showed up good mosquito repellency, Invitro Cytotoxicity test sowed the non toxicity from the fabric and the cage test were resulted with the good mosquito repellency. Then the herbal treated and untreated fabrics are tested with for the AATCC 147 Agar Diffusion and AATCC 100-Quantitative- Broth Dilution test for the antibacterial property. The various objective evaluation tests like fabric tensile strength, abrasion resistance, fabric stiffness, drapeability, wicking, fabric thickness and stiffness were carried out for both treated and untreated sample fabric. Similarly wash durability of the sample is found out by treating it with staphylococcus aureus and Escherichia coli bacterias. The formation of microcapsules in the fabric is found by SEM study. The finished sample treated with microencapsulation lasts upto 25 washes, padding lasts 15 washes. The treated fabric turns pale yellow which does not affect the product. Then the wear study was conducted for the healthy person. Comparing the evaluation results of mosquito repellency, the zone of inhibition of bacteria and the wear study result showed the good result. As per the comments given by the doctor and the wearer, the product was found to be comfortable than the commercial product and reacts against the mosquito and the bacteria so this product is safe and give good effect to mosquito repellency and antibacterial property.

# REFERENCES

## REFERENCE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2. http://www.fibre2fashion.com/industry-article/37/3637/herbal-antimicrobial-finish-for-cotton-fabric1.asp

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12 http://www.ehow.com/facts_5192446_cotton-used-clothing.html

# APPENDIX

## COSTING OF PRODUCT

### COSTING FOR PRODUCT

| Material | Rate | Quantity | Total |
|---|---|---|---|
| Chrysanthemum herb | 120 | 2kg | 240 |
| Mordant (Alum) | 240 | 20 | 28 |
| Cotton fabric | 70 | 3mts | 210 |
| Pad dry cure method | 20/m | 3 | 60 |
| Micro encapsulation | 40/m | 3 | 120 |
| Construction charge | 240 | 1 | 240 |
| Profit(20%) | | | 45 |
| Total | | | 943 |

# TEST REPORT

**LAB NO. : 12168/ 1- 2** DATE: 06/04/2012

**NAME OF CUSTOMER** : KUMARGURU COLLEGE OF TECHNOLOGY

**ADDRESS** : Post Box No.: 2034, Coimbatore – 641 049, Tamil Nadu, India

**REFERENCE** : Letter dated 19/03/2012
Kind Attention: Prof. V. Krishna/ V. Rajesh Kumar

**DATE OF RECEIPT** : 20/03/2012

**DATE OF STARTING** : 22/03/2012 & 03/04/2012

**DATE OF COMPLETION** : 06/04/2012

**SAMPLE DESCRIPTION** : **100% Cotton Fabric** – (Sample attached)

| Sample Nr. | samples / material | Treatment: finish / washes |
|---|---|---|
| 1. | Control sample | Untreated |
| 2. | Fabric sample treated with Chrysanthemum | Treated |

**Name of Test:**

Mosquito Repellency of Fabric Samples

**Procedure:**

U.S. Patent 5,198,287 and USDA Laboratory Method

**Insect Used:**

Female Mosquito - Anopheles species

**No. of Insects Released in Laboratory Tent:**

12 per 10-20 grams of Fabric/half a metre

**No. of hrs. of Incubation :**

3 hrs (intermittent)



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**Result**

3 hrs exposure of mosquito was carried out in a tent made by the provided fabric. Every 1 hour, observations were made about the movements, biting tendency and survival of mosquitoes. Following observations have been made as mean average of experiment conducted two times:

| Sample Identification | Total No. Knock Down | Total No. Unable to Fly | Bite Counts per 3 mins. Exposure | Percentage Repellency Efficiency |
|---|---|---|---|---|
| Control sample | Nil | 0 | 10 | 00 |
| Fabric sample treated with **Chrysanthemum** | Nil | 01 | 02 | 30 |

P.S.: % Repellency Efficiency is equivalent to % protection imparted by the fabric.

For BIOTECH TESTING SERVICES

Dr Shilpa U. Nair
Quality Manager
(Authorized Signatory)



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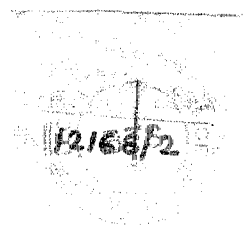
# TEST REPORT

**LAB NO. : 12168/ 2** DATE: 03/04/2012

| | |
|---|---|
| **NAME OF CUSTOMER** | : KUMARGURU COLLEGE OF TECHNOLOGY |
| **ADDRESS** | : Post Box No.: 2034, Coimbatore – 641 049, Tamil Nadu, India |
| **REFERENCE** | : Letter dated 19/03/2012<br>Kind Attention: Prof. V. Krishna/ V. Rajesh Kumar |
| **DATE OF RECEIPT** | : 20/03/2012 |
| **DATE OF STARTING** | : 22/03/2012 |
| **DATE OF COMPLETION** | : 02/04/2012 |
| **SAMPLE DESCRIPTION** | : FABRIC TREATED WITH CHRYSANTHEMUM EXTRACT |




**Name of Test and Test Standard:**

Invitro Cytotoxicity test

**Test Standard:**

1. ISO 10993-5:2009 (E)- Biological evaluation of medical devices; Tests for in vitro cytotoxicity
2. EN ISO 10993-12:2004 (E) - Biological evaluation of medical devices; Sample preparation and reference materials.
3. DIN EN ISO – 105- EO4 – Textiles – Tests for color fastness – colourfastness to perspiration.

**Scope of test:**

Test for cytotoxicity are designed to determine the biological response of mammaliar cells to the test material/ Extract of test material. At the end of the exposure time, the evaluation of the presence and the extent of Cytotoxic effect is assessed. It signifies Biological compatibility of the test material and its potential to cause cell damage.



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E-mail : biotechtestingservices@gmail.com / info@biotechtestingservices.com • Website : www.biotechtestingservices.com

## Cells line and Experimental details:

| | |
|---|---|
| Cell line | : L929 fibroblast cell line;<br>Used for assay for the below stated reasons<br>• Low maintenance<br>• high correlation with specific animal assay<br>• First cell types that attach to implanted medical devices.<br>• Better reproducibility and accuracy of the cytotoxic response. |
| Passage No. | : Cells from PN 21 |
| Cell Culture Medium | : Complete MEM medium with 10% FBS |
| Positive Control | : 0.001% SDS (Sodium Dodecyl sulphate) solution |
| Medium Control / Blank | : Complete MEM medium with 10% FBS |
| Extraction medium | : Acid Perspiration extract as per DIN EN ISO – 105- EO4 |
| Concentration used | : 10%, 25%, 50%and 100% (neat). |

## Incubation Condition:

$37^0$C with 5% Carbon dioxide atmosphere

## Sample Preparation:

Representative portion of the supplied test sample was used for the assay.

## Sample extraction:

1gm sample was sterilized at 121°C for 15mins to which 10 ml extraction medium was added (0.1g/ml) and incubated at 37°C for 24 hrs and the extract pH is adjusted to 7.5 with 0.1N NaOH.

## Assay Principle:

MTT (3-4,5 dimethyithiazol-2-yl)-2,5 diphenyl tetrazolium bromide Cytotoxicity assay. Test procedure is based on measurement of viability of cells via metabolic activity. Yellow water soluble MTT is metabolically reduced in viable cells to a blue violet insoluble Formazan. The number of viable cells co-relates to the colour intensity determined by photometric measurement after dissolving the formazan in DMSO.



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**Assay Procedure:**

L929 cells seeded in 96 well plates at a concentration of 10,000 cells per 100 µl of MEM culture medium per well were maintained in culture for 24 hours to form a semi confluent layer and were exposed to the test material over a range of concentration. After 24 hours exposure, Formazan formation is determined for each treatment concentration and compared to that determined in growth control.

For each treatment the percentage inhibition of growth is calculated by Viability of cells as per formula –

$$\text{Viability Percentage} = \frac{100 \times \text{O. D. 570 nm for extract}}{\text{O. D. 570 nm for blank}}$$

**Evaluation criteria:**

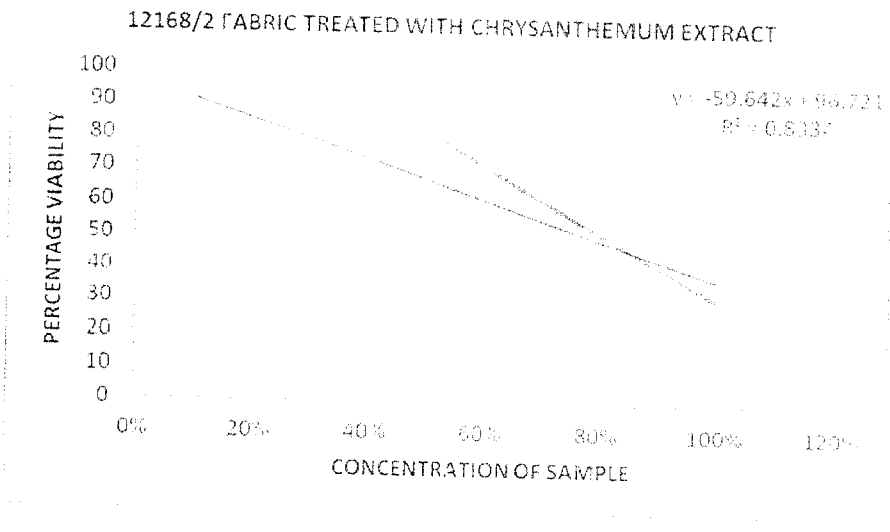
The lower the viability percentage value, the higher the cytotoxic potential.

The percentage viability of 100% test sample is < 70%, it has cytotoxic potential.

The percentage viability of 100% test sample is ≥ 70%, it is non cytotoxic.

**Results:**

| FABRIC TREATED WITH CHRYSANTHEMUM EXTRACT | Negative control | Positive control | Growth control | 10% | 25% | 50% | 100% |
|---|---|---|---|---|---|---|---|
| Percentage of cell viability over control | - | 4.4 | 100 | 83.06 | 132.07 | 80.76 | 30.92 |
| P value | - | - | - | 0.23 | 0.08 | 0.43 | 0.16 |



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E-mail : biotechtestingservices@gmail.com / info@biotechtestingservices.com • Website : www.biotechtestingservices.com

**INTERPRETATION:**

1. For the assay a concentration range from 10%- 100% was maintained.
2. At 100% (neat) concentration – sample was found to be toxic to the L929 cells. IC50 was found to be 78.33% ~ 783.3mg/ml
3. Fabric extract at 50% and lower concentration was found to increase the cell viability, indicating that the treated Fabric was **Non toxic at lesser dilution.**
4. The values obtained were statistically significant with a p-value < 0.05 and a regression coefficient of 0.8334.

**CONCLUSIONS:**

**Fabric treated with Chrysanthemum extract - is Non toxic at lesser dilution.**

**Disclaimer:**

Any cytotoxic effect can be of concern However, it is primarily an indication of potential for invivo toxicity and test material cannot necessarily be considered unsuitable for a given clinical application based solely on cytotoxicity data.

For BIOTECH TESTING SERVICES

Ms. Annette M.
Assay performed by

Dr Shilpa U. Nair
Quality Manager
(Authorized Signatory)



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QUSTIONARIE FOR CHRYSANTHEMUM

1. How long have you used the product?
   a. 1 month b. 15 days c. 10 days d. 5 days
2. How often you use the product?
   a. 2 to 3 times a day b. 1 time a day c. once in week d. twice in a week
3. Overall how satisfied you are with the product?
   a. Very satisfied b. unsatisfied c. somewhat satisfied d. extremely satisfied
4. Dose our product cause any irritation?
   a. Yes b. no
5. Is there any breathable problem while using the product?
   a. Yes b. no
6. Compared to other product categories available, would say our product are?
   a. much better b. somewhat better c. above the same d. somewhat worse
7. Will be use or purchase our product again?
   a. Definitely will b. probably will c. might or might not d. probably will not
8. How likely you are to recommend our product to others?
   a. Definitely will recommend b. probably will recommend c. not sure
   d. will not recommend

# APPENDIX

## COSTING OF PRODUCT

### COSTING FOR PRODUCT

| Material | Rate | Quantity | Total |
|---|---|---|---|
| Chrysanthemum herb | 120 | 2kg | 240 |
| Mordant (Alum) | 240 | 20 | 28 |
| Cotton fabric | 70 | 3mts | 210 |
| Pad dry cure method | 20/m | 3 | 60 |
| Micro encapsulation | 40/m | 3 | 120 |
| Construction charge | 240 | 1 | 240 |
| Profit(20%) | | | 45 |
| Total | | | 943 |