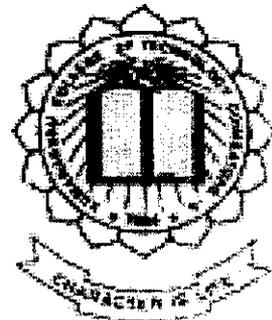


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**DEVELOPMENT OF HERBAL
ANTIMICROBIAL MEDICATED MASK
AND FOOTWEAR FOR DISEASES**



A PROJECT REPORT

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**(An Autonomous Institution affiliated to Anna University of Technology,
Coimbatore)**

APRIL 2011

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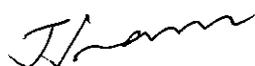
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TABLE OF CONTENTS

ABSTRACT	iv
LIST OF TABLES	x
LIST OF FIGURES	xii
LIST OF PLATES	xiii
1. INTRODUCTION	1
2. REVIEW OF LITERATURE	
2.1 SKIN DISEASES	5
2.2 CAUSES FOR SKIN DISEASES	5
2.3 TYPES OF SKIN DISEASES	
2.3.1 CONTACT DERMATITIS	7
2.3.2 CONTACT URITCARIA	8
2.3.3 ACNE	8
2.3.3.1 CAUSES FOR ACNE	8
2.3.4 SKIN CANCER	9
2.3.5 SKIN INFECTIONS	10
2.3.5.1 BACTERIAL SKIN INFECTIONS	10
2.3.5.2 FUNGAL SKIN INFECTIONS	10
2.3.5.2.1 ATHLETE'S FOOT	11
2.3.5.2.2 CRACKED HEELS	11
2.3.5.2.2.1 SYMPTOMS	11
2.3.5.2.2.2 CAUSES	11
2.3.5.3 VIRAL INFECTIONS	12
2.3.5.4 SKIN INFECTION DUE TO	
AIR AND DUST	13
2.3.5.4.1 DANDRUFF	13
2.3.5.4.1.1 CAUSES	
OF DANDRUFF	13
2.3.5.4.1.2 SYMPTOMS OF	
DANDRUFF	14
2.4 MICRO ORGANISMS	14
2.4.1 TYPES OF MICRO ORGANISMS	15
2.4.1.1 BACTERIA	15
2.4.1.1.1 TYPES OF BACTERIA	
2.4.1.1.2 DEFINITION	15
2.4.1.1.3 STAPHYLOCOCCUS AUREUS	16
2.4.1.1.4 ESCHERCHIA COLI	16

2.4.1.2 FUNGI	17
2.4.1.2.1 ASPERGILLUS NIGER	17
2.4.1.3 VIRUSES	18
2.4.1.4 ALGAE	18
2.5 ANTIMICROBIAL FINISHING	18
2.5.1 NECESSITY OF ANTI MICROBIAL FINISH	18
2.5.2 REQUIREMENTS FOR ANTI MICROBIAL FINISH	19
2.5.3 MECHANISM OF ANTI MICROBIAL ACTIVITY	19
2.5.4 ANTI MICROBIAL SUBSTANCES AND THEIR EFFECT	20
2.5.5 BENEFITS OF ANTI MICROBIAL TEXTILES	22
2.5.6 METHODS OF APPLYING ANTI MICROBIAL FINISH	
2.5.6.1 PAD DRY CURE METHOD	22
2.5.6.2 MICRO ENCAPSULATION	23
2.5.6.2.1 BENEFITS OF MICRO ENCAPSULATION	23
2.5.6.2.2 DIFFERENT APPLICATION OF MICRO ENCAPSULATION	23
2.5.7 FIBERS, YARNS & FABRICS SUITABLE FOR ANTI MICROBIAL FINISH	
2.5.7.1 FIBRES	24
2.5.7.2 YARNS	24
2.5.7.3 FABRICS	24
2.6 NATURAL ANTIMICROBIAL MEDICINAL HERB	25
2.6.1 NEEM	25
2.6.1.1 MEDICINAL PROPERTIES OF NEEM	25
2.6.1.2 MEDICINAL USES OF NEEM	26
2.6.1.3 BENEFITS OF NEEM	26
2.6.1.3.1 NEEM BENEFITS IN HUMAN BEINGS	26
2.6.2 MARIGOLD	27
2.6.2.1 CLASIFICATION	27
2.6.2.2 MEDICINAL PROPERTIES OF MARIGOLD	28
2.6.2.3 MEDICINAL USES OF MARIGOLD	28
2.7 MEDICAL PRODUCTS – DEFINITION	29
2.7.1 HERBAL MEDICATED PRODUCTS	29
3. METHODOLOGY	
3.1 3.1 SELECTION OF MATERIAL	31
3.1.1 COTTON	31

3.2 SELECTION OF NATURAL MEDICINAL HERB	31
3.2.1 NEEM	31
3.2.2 MARIGOLD	32
3.3 SELECTION OF SOLVENT	32
3.4 SELECTION OF SUITABLE EXTRACTION METHOD	33
3.4.1 DRY EXTRACTION PROCEES FOR NEEM	33
3.4.2 DRY EXTRACTION PROCEES FOR MARIGOLD	33
3.5 OPTIMISATION OF PROCESS CONDITIONS	34
3.6 SELECTION OF SUITABLE MORDANT	35
3.7 SELECTION OF FINISHING APPLICATION	
METHOD ON FABRIC	36
3.7.1 PAD – DRY – CURE FINISH APPLICATION	
METHOD	36
3.7.2 MICRO ENCAPSULATION METHOD	36
3.8 SELECTION OF MICRO ORGANISM	37
3.8.1 SELECTED MICROORGANISMS	
3.8.1.1 BACTERIA	37
3.8.1.2 FUNGI	37
3.9 SELECTION OF ANTIBIOTIC	37
3.10 EVALUATION METHODS	
3.10.1 THIN LAYER CHROMATOGRAPHY TEST	38
3.10.2 FTIR TEST METHOD	38
3.11 ANTIMICROBIAL TEST METHOD	
3.11.1 ANTI-BACTERIAL TEST –(AATCC 147 – 1988	
(USA) QUALITATIVE)	39
3.11.2 ANTI-FUNGAL TEST – (AATCC30 QUALITATIVE)	40
3.12 OBJECTIVE EVALUATION	
3.12.1 FABRIC PARTICULARS	40
3.12.2 FABRIC TENSILE STRENGTH	41
3.12.3 FABRIC ABRASION STRENGTH	41
3.12.4 FABRIC STIFFNESS	42
3.12.5 FABRIC THICKNESS	43
3.12.6 FABRIC DRAPE	43
3.12.7 WICKING TEST	44
3.13 SEM STUDY	44
3.14 CONSTRUCTION PROCEDURE	44
3.15 WEAR STUDY	45
3.16 WASH DURABILITY	46
3.17 FEED BACK	46

4. RESULTS AND DISCUSSION

4.1 PRELIMINARY ANTIMICROBIAL ASSESSMENT	47
4.1.1 THIN LAYER CHROMATOGRAPHY	
4.1.1.1 NEEM	47
4.1.1.2 MARIGOLD	47
4.1.2 FTIR	48
4.2 ANTI BACTERIAL ACTIVITY	
4.2.1 ANTI BACTERIAL ACTIVITY (SOLVENT IDENTIFICATION TEST)	
4.2.1.1 NEEM –AATCC 147 - AGAR DIFFUSION TEST - POSITIVE BACTERIA	50
4.2.1.2 NEEM – AATCC 147 – AGAR DIFFUSION TEST - NEGATIVE BACTERIA	50
4.2.1.3 MARIGOLD –AATCC 147 - AGAR DIFFUSION TEST - POSITIVE BACTERIA	51
4.2.1.4 MARIGOLD –AATCC 147 - AGAR DIFFUSION TEST - NEGATIVE BACTERIA	51
4.3 OPTIMISATION OF PROCESS CONDITIONS	
4.3.1 NEEM	52
4.3.2 MARIGOLD	53
4.4 ANTIFUNGAL ACTIVITY	
4.4.1 NEEM	54
4.4.2 MARIGOLD	55
4.5 OBJECTIVE EVALUATION	
4.5.1 FABRIC TENSILE STRENGTH	
4.5.1.1 NEEM	55
4.5.1.2 MARIGOLD	57
4.5.2 ABRASION RESISTANCE	
4.5.2.1 NEEM	59
4.5.2.2 MARIGOLD	61
4.5.3 FABRIC STIFFNESS	
4.5.3.1 NEEM	63
4.5.3.2 MARIGOLD	65
4.5.4 FABRIC THICKNESS	
4.5.4.1 NEEM	67
4.5.4.2 MARIGOLD	69
4.5.5 FABRIC DRAPE	
4.5.5.1 NEEM	71
4.5.5.2 MARIGOLD	73
4.5.6 WICKING TEST	75

4.6 WASH DURABILITY TEST	
4.6.1 NEEM – AATCC 147 QUALITATIVE – AGAR DIFFUSION TEST BACTERIA	75
4.6.2 MARIGOLD – AATCC 147 QUALITATIVE – AGAR DIFFUSION TEST BACTERIA	77
4.7 SEM STUDY	
4.7.1 NEEM	79
4.7.2 MARIGOLD	80
CONCLUSION	
BIBLIOGRAPHY	
APPENDICES	

LIST OF TABLES

S.NO	TITLE	PAGE NO.
1.	ORTHOGONAL DESIGN TABLE	34
2.	ORTHOGONAL DESIGN OF EXPERIMENTS	34
3.	FTIR - INFRARED ABSORPTION FREQUENCIES OF UNTREATED AND TREATED COTTON (CELLULOSE)	48
4.	NEEM – AATCC 147 – AGAR DIFFUSION TEST – (STAPHYLOCOCCUS AUREUS)	50
5	NEEM – AATCC 147 – AGAR DIFFUSION TEST – BACTERIA (ESCHERICHIA COLI)	50
6	MARIGOLD – AATCC 147 – AGAR DIFFUSION TEST (STAPHYLOCOCCUS AUREUS)	51
7.	MARIGOLD – AATCC 147 – AGAR DIFFUSION TEST (ESCHERICHIA COLI)	51
8.	OPTIMIZATION OF PROCESS PARAMETERS - NEEM	52
9.	OPTIMIZATION OF PROCESS PARAMETERS - MARIGOLD	53
10	NEEM – AATCC 30 QUALITATIVE – AGAR DIFFUSION TEST- FUNGI (ASPERGILLUS NIGER)	54
11.	MARIGOLD - AATCC 30 QUALITATIVE – AGAR DIFFUSION TEST - FUNGI (ASPERGILLUS NIGER)	55
12.	FABRIC TENSILE STRENGTH-UNTREATED FABRIC	55
13.	FABRIC TENSILE STRENGTH - NEEM TREATED FABRIC (PADDING)	56
14.	FABRIC TENSILE STRENGTH - NEEM TREATED FABRIC (MICRO ENCAPSULATION)	56
15.	FABRIC TENSILE STRENGTH - UNTREATED FABRIC	57
16.	FABRIC TENSILE STRENGTH -MARIGOLD TREATED FABRIC (PADDING)	58
17.	FABRIC TENSILE STRENGTH - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)	58
18.	ABRASION RESISTANCE - UNTREATED FABRIC	59
19.	ABRASION RESISTANCE - NEEM TREATED FABRIC (PADDING)	60
20.	ABRASION RESISTANCE - NEEM TREATED FABRIC (MICRO ENCAPSULATION)	60
21.	ABRASION RESISTANCE - UNTREATED FABRIC	61
22.	ABRASION RESISTANCE - MARIGOLD TREATED FABRIC (PAD)	62

23.	ABRASION RESISTANCE - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)	62
24.	FABRIC STIFFNESS - UNTREATED FABRIC	63
25.	FABRIC STIFFNESS - NEEM TREATED FABRIC (PADDING)	64
26.	FABRIC STIFFNESS - NEEM TREATED FABRIC (MICRO ENCAPSULATION)	64
27.	FABRIC STIFFNESS - UNTREATED FABRIC	65
28.	FABRIC STIFFNESS - MARIGOLD TREATED FABRIC (PADDING)	66
29.	FABRIC STIFFNESS - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)	66
30.	FABRIC THICKNESS - UNTREATED FABRIC	67
31.	FABRIC THICKNESS - NEEM TREATED FABRIC (PADDING)	68
32.	FABRIC THICKNESS - NEEM TREATED FABRIC (MICRO ENCAPSULATION)	68
33.	FABRIC THICKNESS - UNTREATED FABRIC	69
34.	FABRIC THICKNESS - MARIGOLD TREATED FABRIC (PADDING)	69
35.	FABRIC THICKNESS - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)	70
36.	FABRIC DRAPE - UNTREATED FABRIC	71
37.	FABRIC DRAPE - NEEM TREATED FABRIC (PADDING)	72
38.	FABRIC DRAPE - NEEM TREATED FABRIC (MICRO ENCAPSULATION)	72
39.	FABRIC DRAPE - UNTREATED FABRIC	73
40.	FABRIC DRAPE - MARIGOLD TREATED FABRIC (PADDING)	73
41.	FABRIC DRAPE - MARIGOLD TREATED FABRIC (MICROENCAPSULATION)	74
42.	WICKING TEST	75
43.	WASH DURABILITY - NEEM TREATED FABRIC (PADDING)	76
44.	WASH DURABILITY - NEEM TREATED FABRIC (MICRO ENCAPSULATION)	76
45.	WASH DURABILITY - MARIGOLD TREATED FABRIC (PADDING)	77
46.	WASH DURABILITY - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)	78

LIST OF FIGURES

S.NO	TITLE	PAGE NO.
1.	FTIR ANALYSIS – NEEM	49
2.	FTIR ANALYSIS – MARIGOLD	49
3.	OPTIMIZATION OF PROCESS PARAMETERS - NEEM	53
4.	OPTIMIZATION OF PROCESS PARAMETERS - MARIGOLD	54
5.	FABRIC TENSILE STRENGTH - NEEM	57
6.	FABRIC TENSILE STRENGTH - MARIGOLD	59
7.	ABRASION RESISTANCE - NEEM	61
8.	ABRASION RESISTANCE -MARIGOLD	63
9.	FABRIC STIFFNESS –NEEM	65
10.	FABRIC STIFFNESS –MARIGOLD	67
11.	FABRIC THICKNESS - NEEM	69
12.	FABRIC THICKNESS - MARIGOLD	71
13.	FABRIC DRAPE - NEEM	73
14.	FABRIC DRAPE -MARIGOLD	74
15.	WICKING TEST	75
16.	WASH DURABILITY NEEM	77
17.	WASH DURABILITY MARIGOLD	

LIST OF PLATES

S.NO	TITLE	PAGE NO.
1.	NEEM – LEAVES – POWDER – EXTRACT	81
	MARIGOLD – FLOWER – POWDER- EXTRACT	81
2..	OPTIMISATION OF SOLVENT – NEEM	82
3.	OPTIMISATION OF SOLVENT – MARIGOLD	82
4.	NEEM - ANTI-BACTERIAL ACIVITY	83
5.	MARIGOLD - ANTI-BACTERIAL ACIVITY	83
6.	OPTIMISATION OF PROCESS CONDITIONS -BEST ZONE	84
7.	ANTI FUNGAL ACTIVITY (AATCC 30)	84
	MACHINES USED FOR APPLYING FINISH TO THE FABRIC	
8.	PADDING MANGLES	85
9.	MICRO ENCAPSULATION METHOD	86
10.	CONSTRUCTED PRODUCTS - NEEM PRODUCTS	87
11.	CONSTRUCTED PRODUCTS - MARIGOLD PRODUCTS	87
12.	WEAR STUDY–NEEM PRODUCT	88
13.	WEAR STUDY–MARIGOLD PRODUCT	88
14.	WASH DURABILITY– NEEM - S.AUREUS	89
15.	WASH DURABILITY– MARIGOLD – S. AUREUS	90
16.	WASH DURABILITY - NEEM – ECOLI	91
17.	WASH DURABILITY - MARIGOLD – ECOLI	92
18.	MACHINERIES USED FOR ANTIMICROBIAL TEST	93
19.	MACHINERIES USED FOR FABRIC TESTING	94
20.	WICKING TEST	95

ABSTRACT

ABSTRACT

Health and hygiene are the primary requirements for human beings to live comfortably and work with maximum efficiency. To protect the mankind from pathogens and to avoid from cross infection, a special finish like antimicrobial finish has become necessary. The extracts from root, stem, leaf, flower, fruit and seeds of diverse species of natural plants exhibit anti-microbial activity. This project involves the application of Neem and Marigold herbal extracts on the textile materials. The anti-microbial compounds are present in the selected herbs are identified through TLC and FTIR tests. The solvents like Water, Ethanol, Methanol, Hexane extracts with different concentrations, temperature and time were used to optimize the level of antimicrobial activity by using Orthogonal Design Table. From the optimization results and the zone of inhibition of microbial growth, the solvent water, 50% herbal extracts, temp-50°C, and time 30mins has been chosen as the best process conditions to be followed to finish the final product. These herbal extracts can be applied on the fabric by padding method and micro encapsulation method and we have analyzed that than the padding process, the micro encapsulation process enhances the durability and controlled release of extracts. And then the antimicrobial activity of the finished fabric was assessed against positive, negative bacteria's and fungi that normally exist in the environment. The AATCC 147 and 30 qualitative antimicrobial tests and objective evaluation tests are also conducted for all the Neem and Marigold treated and untreated samples which show better results. The application of these both the herbal extract on cotton fabric in padding process lasts up to 15 washes and in micro encapsulation process lasts up to 20 washes. The wear study was conducted for mask and footwear for 10 persons of different age groups with diseases. The examination and wearer comments shows that our product gives a good result in curing the skin diseases like acne, dandruff, cracked skin and athlete's foot. The product developed in this project will be best suited for various skin infections in the medical field.

INTRODUCTION

1. INTRODUCTION

Textile is the widest field which contributes major percentage of economy. Today, the term technical textiles have emerged as the most widely acceptable term for this expanding field of textile applications. These technical textiles are defined as textile materials and products, primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics. The textiles which are used for the special purposes such as medical textiles, geo-textiles and water proof breathable fabric are called Technical Textile. The role of technical textiles has become so eminent that the future of textile industry in the next few decades will be determined by its performance in the area of technical textiles.

Medical textiles are the textile products and constructions for medical applications. They are used for first aid, clinical or hygienic purposes and rehabilitation. Medical textiles is one of the major growth areas within technical textiles and the use of textile materials for medical and healthcare products ranges from simple gauze or bandage materials to scaffolds for tissue culturing and a large variety of prostheses for permanent body implants.

Humans have gathered food and medicinal herbs ever since their arrival on earth and were guided then by instinct followed by experience and also by rational thought. For millions of years, mankind has fared quite well using this approach, but after the development of science and technology people felt that the current state of affairs was quite satisfactory and hence they failed to support research and education adequately. It is time to examine more closely how diseases can be treated more efficiently.

Microorganisms that are capable of causing disease are called pathogens. Although microorganisms that cause disease often receive the most attention, it is important to note that most microorganisms do not cause disease. In fact, many microorganisms provide some protection against harmful microorganisms because they effectively compete with the harmful organisms for resources preventing them from growing.. There are several different types of microscopic pathogens including bacteria, viruses, fungi or molds, and microscopic animals. A true pathogen is an infectious agent that causes disease in virtually any susceptible host. Opportunistic pathogens are potentially infectious agents that rarely cause disease in individuals

with healthy immune systems. The terms "infection" and "disease" are not synonymous. An infection results when a pathogen invades and begins growing within a host. Disease results only if and when, as a consequence of the invasion and growth of a pathogen, tissue function is impaired.

The control of microbial growth is necessary in many practical situations, and significant advances in agriculture, medicine and food science have been made through study of this area of microbiology. "Control of microbial growth" as used here means to inhibit or prevent growth of microorganisms. This control is affected in two basic ways: (1) by killing microorganisms or (2) by inhibiting the growth of microorganisms. Control of growth usually involves the use of physical or chemical agents which either kill or prevent the growth of microorganisms.

Textile materials are the good carriers of various types of microorganisms and can cause health related problems to the wearer. Health and hygiene are the primary requirements for human beings to live comfortably and work with maximum efficiency. To protect the mankind from pathogens and to avoid cross infection, a special finish like antimicrobial finish has become necessary. As consumers have become more aware of hygiene and potentially harmful effects of microorganisms, the demand for anti-microbial finished clothing is increasing.

Nature has contributed a lot to the medical field with its stock of herbs to make natural products, whose main advantage is that they do not offer any harmful consequences. The most amazing thing to use natural products is that they are always beneficial. While natural products have been verified as being highly advantageous, some people are still doubtful about the uses of natural enhancers over consulted medication. Some of the many advantages of natural enhancers as compared to consulted medicines are described as follows:

- Neither natural medicines do not need any recommendation like the prescribed drugs nor are they managed by FDA rules and directions. You can always order a natural medicine to be shipped from an internet store to your doorstep without having a checkup from a doctor.
- Consulted medication have been assumed to cause many harmful effects like flushing, head pains, stomach pains and even eyesight problems. They have even been associated with heart damages, while on the other side; natural products are likely to proffer extra

benefits as a cause of the components used in them. Investigation shows constructive results from patients.

- An added benefit of preferring a natural product over a consulted drug is that it is less expensive that a person can easily buy 90 tablets in just \$160 from inexpensive internet pharmacies.
- The prices highly fluctuate according to the pharmacy from where the medicine has been purchased and even so many internet pharmacies have been suspected of selling useless as well as watered down drugs to patients. So comparatively, natural male enhancers are much less costly than consulted medication.
- The advantages of taking natural products are visible to every other person but still the preference of every individual on natural medicines over consulted drugs is the decision of the patient. Selecting the correct natural medicine can definitely cause good outcome

Medicinal herbs are the local heritage with global importance. Medicinal herbs have curative properties due to presence of various complex chemical substance of different composition, which are found as secondary plant metabolites in one or more parts of these plants. Some of the medicinal herbs are Neem, Marigold and Aloe Vera. Of the above listed herbs we have chosen Neem and marigold which has the best remarkable properties for curing skin diseases like dandruff, pimples, cracked skin and scarf's etc.

Neem leaves have anti-bacterial and anti-fungal properties which help in treating skin problems. It cures right from skin diseases to diabetes, from cholesterol to hair problems, from ulcers to dental problems. Marigold has a long history as a superior antibacterial when used internally and externally and has been used to heal many skin irritations, wounds, and injuries, including Eczema, Athlete's foot, herpes and gingivitis.

The present investigation aims at developing eco-friendly natural anti-microbial finished products from herbal extracts using different solvents, concentrations, temperature and time. The herbal extracts are applied using pad-dry and microencapsulation method for controlling the skin diseases like dandruff, pimples, cracked skin etc through the face mask and foot wear. Hence an attempt has been made in this study to finish woven cotton fabrics using Neem (*Azadirachta Indica*) and Marigold (*Calendula officinalis*) with the following objectives:

- To arrest the microbial metabolism on textile materials.
- Effective control of skin disease causing micro-organism.
- To compare the natural medicinal herbal effect with commercial antibiotics.
- To reduce the skin disorders without causing skin effects.
- To develop a natural eco-friendly product.
- To develop the cost effective and safety product for the customer.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1 SKIN DISEASES

Skin diseases are most common form of infections occurring in people of all ages.^[71] Skin diseases are difficult conditions to live with, to say the very least. Though some skin diseases may cause minimal discomfort, the visual effects of the conditions can cause significant self esteem and confidence issues. The majority of skin diseases cause scarring or disfigurement. Skin diseases run the gambit from barely noticeable to fatal.^[39]

Most of the skin infections treatment takes long time to show their effects. The problem becomes more worrisome if the ailment does not respond to skin disorder treatments. There are not many statistics to prove the exact frequency of skin diseases in this country, but general impression is 10-20 percent of patients seeking medical advice suffer from skin diseases. The skin conditions are prevalent across all parts of the world. Diseases of the skin account for a great deal of misery, suffering, incapacity and economic loss.^[71]

2.2 CAUSES FOR SKIN DISEASE

The causes of skin disorders range from sunburn and drug reactions to genetics and pregnancy. Many of the causes can be avoided with a little prevention, while others are more random in occurrence. Below are the most common causes of skin disorders.^[51]

- **Sun Exposure, Sunburn and Heat Rash**

Sunlight contains harmful ultraviolet rays that can damage the skin. Sunburn increases your chance of developing a skin condition, as does tanning and lengthy unprotected exposure to the sun. Skin cancer is the best known condition caused by sunburn and tanning. Premature aging of the skin also occurs with prolonged exposure to the sun.

In hot, humid weather, prickly heat rash can develop. Staying cool and dry, wearing light, cool clothing and drying thoroughly after bathing are the best defenses against the irritating prickly heat of the heat rash pustules.^[68]

- **Pregnancy**

Certain skin conditions occur more often during pregnancy. Almost ninety percent of pregnant women have temporary hyper pigmentation where naturally darker areas of pigmentation (such as freckles, scars, moles, and nipples) appear darker than usual. The condition slowly disappears after childbirth.^[50]

- **Natural Irritants and Allergies**

Many temporary skin problems are caused by natural sources. Insect bites inflame and irritate the skin. Poison ivy and other irritating plants cause skin rashes, pustules and itching. Parasites such as lice and mites can cause extreme itching and discomfort.

A food allergy can cause skin rashes, hives and even facial swelling. While the symptoms of a food allergy are often dramatic, tracking down the food that causes the allergic reaction can sometimes take time.

Diaper rash is caused by exposure to urine and feces, allergies to disposable diapers, soaps and detergents, or by diapers that are worn too tightly or do not breathe. While most cases of diaper rash are mild and resolve in a day or two, more severe cases form painful pustules that cover the baby 's bottom, and may even result in a yeast infection. All cases of diaper rash should be monitored for potential secondary infection by bacteria or yeast.^[37]

- **Drug Reactions**

Adverse drug reactions can cause rashes, hives, and swelling. As mentioned above, some medications increase the skin's sensitivity to the sun.^[68]

- **Genetics**

Finally, there are genetic propensities for skin conditions. People whose parents suffer from skin-affecting allergies may themselves be at increased risk of developing allergies. Acne has a hereditary pattern, as do some other common skin conditions.^[44]

2.3 TYPES OF SKIN DISEASES

As the largest organ of the body, the skin is a common site of disease. Serving as the body's interface with the environment, the skin is vulnerable to an array of infectious diseases that occur throughout life. Bacteria, viruses and fungi cause numerous types of skin diseases that range in severity from mild to potentially life threatening. Additionally, the skin is a common site for abnormal immune system activity, which causes several types of chronic skin diseases. [61]

There are many reasons why skin diseases can occur and several different types of disorder can affect people at work. Most work-related skin diseases are contact dermatitis and have been caused by contact with an external agent.

However, external agents are also involved in an important minority of other work-related skin diseases. These include:

- Contact dermatitis
- Contact urticaria
- Acnes
- Cancers
- Skin infections^[56]

2.3.1 CONTACT DERMATITIS:

As the term implies, contact dermatitis is a disease resulting from skin coming into contact with an outside agent. These agents can be chemical, biological or physical in nature. There are two types of contact dermatitis associated with skin exposure to chemicals: Irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD).

The signs of contact dermatitis include redness, swelling, blistering, flaking and cracking. It can lead to itching, bleeding and puss formation. [57]

2.3.2 CONTACT URTICARIA (IMMEDIATE CONTACT REACTIONS)

The skin contact with an irritant results in itchy rash within minutes to an hour. They disappear within twenty-four hours, usually within a few hours. Contact urticaria is also known as nettle rash or hives. It is typified by the wheal (swellings) and flare at the site of contact. The affected person may suffer from itching, tingling or burning sensations. ^[58]

2.3.3 ACNE

Acne is the diagnostic term for pimples. It is a chronic inflammatory disease in which there are few or many skin lesions. These may be minute, or may be large and disfiguring. The usual form is small red, bright or dark red pin-head or pea-size papules. These appear more frequently on the forehead, chin or lower jaw and black-heads usually are quite numerous in the same area. The skin may appear thick, dirty and greasy and pus and sebaceous (oily or greasy) matter can be expressed from the lesions. After they have reached a certain point there may be a succession of these eruptions, some forming, some maturing and others healing at the same time. These are disfiguring and annoying but can practically invariably be completely removed, though not infrequently some of the scars of previous deep blemishes remain. ^[42]

2.3.3.1 CAUSES FOR ACNE

No one factor causes acne. Acne happens when sebaceous (oil) glands attached to the hair follicles are stimulated at the time of puberty by elevated levels of male hormones. Sebum (oil) is a natural substance which lubricates and protects the skin. Associated with increased oil production is a change in the manner in which the skin cells mature so that they are predisposed to clog the follicular openings or pores. The clogged hair follicle gradually enlarges, producing a bump. As the follicle enlarges, the wall may rupture, allowing irritating substances and normal skin bacteria access into the deeper layers of the skin, ultimately producing inflammation.

Inflammation near the skin's surface produces a pustule; deeper inflammation results in a papule (pimple); deeper still and it's a cyst. If the oil breaks through to the surface, the result is a "whitehead." If the oil accumulates melanin pigment or becomes oxidized, the oil changes from

white to black, and the result is a "blackhead." Blackheads are therefore not dirt and do not reflect poor hygiene.

In occasional patients, the following may be contributing factors:

- **Pressure:** In some patients, pressure from helmets, chin straps, collars, suspenders can aggravate acne.
- **Drugs:** Some medications may cause or worsen acne, such as those containing iodides, bromides, or oral or injected steroids (either the medically prescribed prednisone [Deltasone, Orasone, Prednicen-M, Liquid Pred] or the steroids that bodybuilders or athletes take). Other drugs that can cause or aggravate acne are anticonvulsant medications and lithium (Eskalith, Lithobid), which is used to treat bipolar disorder. Most cases of acne however, are not drug related.
- **Occupations:** In some jobs, exposure to industrial products like cutting oils may produce acne.
- **Cosmetics:** Some cosmetics and skin-care products are pore clogging ("comedogenic"). Of the many available brands of skin-care products, it is important to read the list of ingredients and choose those which have water listed first or second if you are concerned about acne. These "water-based" products are usually safe.^[63]

2.3.4 SKIN CANCER

Exposure to radiation can lead to skin cancer, most commonly this comes from exposure to the sun. Therefore outside workers are particularly at risk. People who are exposed to ionizing and non-ionizing radiation may be susceptible to work related cancers.

Some chemicals can cause cancer on the skin others may contribute to cancers found in other parts of the body. The use of unrefined mineral oils has in the past led to skin cancer affecting the exposed skin of the hands and forearms. Oil-soaked clothing and oily rags kept in overalls caused scrotal cancer. The uses of refined oils together with changes in work practice and improved personal hygiene have reduced this risk.

2.3.5 SKIN INFECTIONS, INFESTATIONS AND INSECT BITES

Skin infections, infestations and insect bites may be occupational in origin:

- Bacteria
- Fungi
- Viruses
- Infections due to air & dust, remarks^[59]

2.3.5.1 BACTERIAL SKIN INFECTIONS

Bacterial infections of the skin are the most common types of skin infections. There are mainly two types of bacteria causing these infections are Staphylococcus Aureus and Streptococcus Aureus. The list of common bacterial infections, many of which are staph infections of the skin as it is caused by staphylococcus aureus bacteria.

- Skin Boils
- Erysipelas
- Cellulitis
- Folliculitis
- Furuncle
- Erythrasma
- Impetigo

2.3.5.2 FUNGAL INFECTIONS OF THE SKIN

Fungal infections of the skin are caused by the fungi that reside on our body. Most of the times they are not problematic but, sometimes they can cause skin infections in certain areas of the body due to various reasons. Fungi are most common in conditions where it is warm and moist all the time and these are the areas that are mainly affected by fungi's. Given below is the list of different fungal infections of the skin including the skin yeast infections

- Athlete's Foot
- Tinea Versicolor

- Jock Itch
- Ringworm

2.3.5.2.1 Athlete's Foot

One of the most common fungal infections of the skin is athlete's foot which as the name suggests occurs on the feet. It is a more common skin infection found in men as compared to women and is seen in those who wear tight-fitting shoes which provide the best environment to the fungi's. There are mainly three types of this fungal infection namely, inter-digital, moccasin and vesicular. Out of the three, inter-digital athlete's foot is the most common infection. [42]

2.3.5.2.2 Cracked heels

Cracked heels are a condition of thickening and fissuring of the skin on the heel of the foot. This is a common foot problem. Cracked heels are often referred to as fissures. When the fissures are deep, the skin bleeds easily and causes a lot of pain.

2.3.5.2.3 Symptoms of cracked heels

The most common symptoms of cracked heels are:

- Hard growth of skin on the outer edge of the heel.
- Yellow or dark skin on the heel.
- Pain while walking.
- Increased pain in thin soles or open back shoes.
- Red or flaky patches on the heel of the foot
- Peeling and cracked skin
- Itchy skin

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2.3.5.2.3 Causes for cracked heels

There are many causes of cracked heels. Some of the most common causes are:

- Inactive sweat glands

- Dry skin
- Prolonged standing
- Obesity
- Wearing shoes with an open back
- Surgery to the lower extremities
- Heel Spurs
- Mal-aliment of the metatarsal bones
- Flat feet
- High arched feet
- Improperly fitting shoes
- Athlete's foot
- Psoriasis, reports^[62]

2.3.5.3 VIRAL INFECTIONS

Viruses are a major cause of quite a few rashes that people may develop. When a person has a rash due to a viral infection, may experience bumps all over the body. These bumps are red and itchy when formed. Gradually, they turn from the red to a yellow and finally a flaky brown as they fall off. The itchy rash can often times be very painful for people. Though the rashes generally disappear within a fortnight, it is always better to have an expert opinion. Given below are the most common virus rashes that people can experience:

- Chickenpox
- Measles
- Rubella
- Roseola Rash
- Shingles
- Fifth Disease
- Warts
- Molluscum Contagiosum, reports^[42]

2.3.5.4 SKIN INFECTIONS DUE TO AIR AND DUST

2.3.5.4.1 DANDRUFF

Dandruff is a very common skin condition that nearly all people experience at one point in their lives regardless of age or ethnicity. It affects the not just the scalp but also the ears, eyebrows, sides of the nose, beard, and less commonly the central (often hair-bearing) part of the chest. Dandruff can affect any hair-bearing area or an area with even very small hair follicles. Other names for dandruff are seborrheic dermatitis or seborrhea. Dandruff is seen in all ages from babies to the elderly. In infants, scalp dandruff is commonly known as "cradle cap."^[46]

2.3.5.4.1.1 Causes for dandruff

The exact cause of dandruff is unknown. Possible causes and associations include increased oil production, oily skin, increased skin secretions and increased numbers of normal skin yeasts.

Bacteria have not been found to cause dandruff. Dandruff is not a fungal infection and is not the same as scalp "ringworm," which is actually a fungal infection called tinea capitis. Dandruff is not contagious.

- Common triggers (factors that may worsen) of dandruff include the following:
 - Increased oil production
 - Oily skin
 - Oily scalp
 - Sweating
 - Poor hygiene
 - Weather (hot and humid or cold and dry)
 - Infrequent washing or shampooing
 - Concurrent yeast or fungal

- Risk factors for dandruff include the following:

- People with extreme or severe cases of dandruff usually also have other chronic health conditions
- Dandruff probably has a small hereditary component making it more common to run in families, reports ^[47]

2.3.5.4.1.2 Symptoms of dandruff

Medical professionals and skin specialists called dermatologists commonly refer to dandruff as seborrhea or seborrheic dermatitis. The signs and symptoms include:

- White flakes on shoulders of dark clothing
- Itchy scalp
- Dry facial skin
- Recurrent ear "eczema"
- Facial rash by eyebrows, nose, and ears
- Oily scalp and facial skin with dry flakes
- Eyebrow dandruff
- Beard dandruff
- Chest rash with dry flakes and red spot, reports ^[48]

2.4 MICRO-ORGANISMS

A microbe (microorganism) is a tiny individual living thing that is way too small to be seen by the human eye alone. The only way this tiny organism can be seen is by using a microscope. This is why microbes are often called "microscopic organisms."^[70]

Microbes are the first living creatures that have appeared on the earth. They formed the first biosphere and continue to carry out a multitude of essential geochemical activities that prepared the Earth for the eventual evolution of macroscopic life. Microorganisms are found everywhere in nature, owing to the existence of extremophiles, and adapted to generally hostile environments. ^[43]

These organisms are found almost everywhere you can think of here on Earth – in air, water, soil, rock and even in plants, animals and the human body. Some microbes can live in very hot temperatures and others can live in the freezing cold. Some need oxygen to grow and stay alive, while others survive without it.^[70]

2.4.1 TYPES OF MICRO ORGANISMS

There are four types of micro organisms. It includes

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

2.4.1.1 Bacteria

They are generally small, range in size from 0.1 to 15 micron with some "giants" that may reach half a millimeter. They make up the most metabolically diverse group of living organisms and tend to live and grow under wide ranges of temperature, pH and oxygen concentration. Carbon molecules represent an important nutrient source for bacteria. Although some are parasitic to animals and plants, the majority of bacteria are free-living having either a neutral or beneficial relationship with humans and other animals and plants. One of their most remarkable characteristics is their ability to multiply rapidly.^[43]

2.4.1.1.1 Types of bacteria:

- a) *Gram positive bacteria*
- b) *Gram negative bacteria*

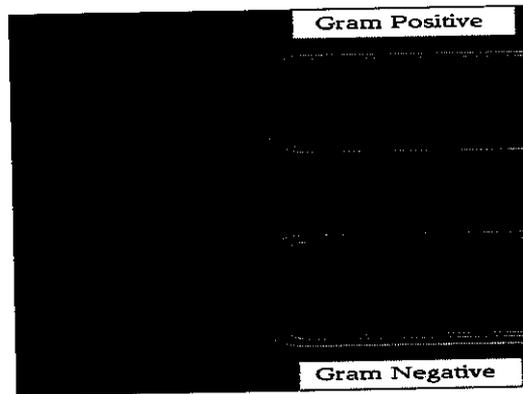
2.4.1.1.2 Definition

The bacteria which takes place gram stain made up of Crystal violet and Iodine are called **gram positive (+)** bacteria and those bacteria does not colored by gram stain are called **gram negative (-)** bacteria. The gram staining method was first used by the scientist Cristian Gram of Denmark in the year 1884. ^[41]

The two gram positive and two gram negative bacteria are

Gram positive bacteria - *Staphylococcus aureus*, *Bacillus subtilis*

Gram negative bacteria- *Escherichia coli*, *Salmonella aureus*.^[41]



2.4.1.1.3 *Staphylococcus Aureus*

Staphylococcus Aureus is a facultative anaerobic, Gram-positive Coccus and is the most common cause of staph infections.^[2] *Staphylococcus Aureus* can cause a range of illnesses from minor skin infections such as pimples, impetigo, boils (furuncles), cellulitis folliculitis, carbuncles, scalded skin syndrome and abscesses, to life-threatening diseases such as pneumonia, meningitis, osteomyelitis, endocarditis, toxic shock syndrome (TSS), chest pain, bacteremia, and sepsis. 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.^[10] *Staphylococcus 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.^[16]

2.4.1.1.4 *Escherichia coli*

Escherichia coli are a Gram-negative rod-shaped bacterium that is commonly found in the lower intestine of warm-blooded organisms (endotherms).^[25] Most *E. coli* strains are harmless but some can cause serious food poisoning in humans and are occasionally responsible for product recalls.^[8,35] The harmless strains are part of the normal flora of the gut and can

benefit their hosts by producing vitamin K₂ and by preventing the establishment of pathogenic bacteria within the intestine.^[1]

2.4.1.2 FUNGI

Fungi are a large and diverse group of eukaryotic, non-photosynthetic, spore-forming organisms. They have rigid cell walls. Respiration takes place in bodies called mitochondria in the cytoplasm. Fungal cells have an elaborate arrangement of internal membranes. Fungi can be divided into two broad groups:

- Filamentous fungi (including moulds and macro fungi)
- Yeasts.

Fungi can be separated into yeasts and molds. Corrosion damage to aircraft fuel tanks is one of the well-known problems associated with fungi. Fungi tend to produce corrosive products as part of their metabolism these by-products that are responsible for corrosive attack. Furthermore, fungi can trap other materials leading to fouling and associated corrosion problem.
[43]

2.4.1.2.1 Aspergillus Niger

It is a filamentous ascomycete fungus that is ubiquitous in the environment and has been implicated in opportunistic infections of humans^[21]. Aspergillus Niger is most widely known for its role as a citric acid producer^[13]. With production of citric acid at over one million metric tons annually Aspergillus Niger citric acid production serves as a model fungal fermentation process. As a common member of the microbial communities found in soils Aspergillus Niger plays a significant role in the global carbon cycle.^[26]

2.4.1.3 VIRUSES

Viruses are very small, ranging between 0.01 and 0.03 mm, and only be visualized under electron microscope. They cannot live independently and only multiply inside the cells of other organisms. However, their demand for a host is fairly specific. It is unlikely that a crustacean

virus will attack humans or fish. Viruses are also the simplest of all organisms and are made of nucleic acid (either DNA or RNA), frequently coated with a protein layer^[43]

2.4.1.4 ALGAE

Algae are a diverse group of eukaryotic organisms that contain chlorophyll and carry out photosynthesis. Some contain other photosynthetic pigments which give them their characteristic color, most algae are green, but some are red. They occur in a wide range of forms from microscopic to macroscopic.^[43]

2.5 ANTIMICROBIAL FINISHING

Antimicrobials do not all work the same. The vast majority of antimicrobials work by leaching or moving from the surface on which they are applied. This is the mechanism used by leaching antimicrobials to poison a microorganism. Such chemicals have been used for decades in agricultural applications with mixed results. Besides affecting durability and useful life leaching technologies have the potential to cause a variety of other problems when used in garments. These include their negative effects because they can contact the skin and potentially affect the normal skin bacteria, cross the skin barrier, and/or have the potential to cause rashes and other skin-irritations.

A more serious problem with leaching technologies has to do with their allowing for the adaptation of microorganisms. An antimicrobial with a completely different mode of action than the leaching technologies is a molecularly bonded unconventional technology. The bound unconventional antimicrobial technology, an organ functional silane has a mode of action that relies on the technology remaining affixed to the substrate killing microorganisms as they contact the surface to which it is applied. Effective levels of this technology do not leach or diminish over time. The technology actually polymerizes with the substrate making the surface antimicrobial. This type of antimicrobial technology is used in textiles that are likely to have human contact or where durability is of value.^[3]

2.5.1 NECESSITY OF ANTIMICROBIAL FINISH

Antimicrobial treatment for textile materials is necessary to fulfill the following objectives:

- To control microorganisms
- To reduce odor from perspiration, stains and other soil on textile material
- To reduce the risk of cross infection being carried by feet from ward to ward in hospital
- To control spread of disease and danger of infection following injury
- To control the deterioration of textiles particularly fabrics made from natural fiber caused by mildew.

2.5.2 REQUIREMENTS FOR ANTIMICROBIAL 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:

- Durability to washing, dry cleaning and hot pressing
- Selective activity to undesirable microorganisms
- Should not produce harmful effects to the manufacturer, user and the environment
- Should comply with the statutory requirements of regulating agencies
- Compatibility with the chemical processes
- Easy method of application
- No deterioration of fabric quality
- Resistant to body fluids
- Resistant to disinfections/sterilization, report ^[4]

2.5.3 MECHANISM OF ANTIMICROBIAL ACTIVITY

Negative effect on the vitality of the microorganisms is generally referred to as antimicrobial. The degree of activity is differentiated by the term cidal that indicates significant destruction of microbes and the term ecstatic represents inhibition of microbial growth without much destruction. The activity which affects the bacteria is known as antibacterial and that of fungi is anti-mycotic. The antimicrobial substances function in different ways. In the conventional leaching type of finish the species diffuse and poison the microbes to kill. This type of finish shows poor durability and may cause health problems. The non-leaching type or

bio-static finish shows good durability and may not provoke any health problems. A large number of textiles with antimicrobial finish function by diffusion type. The rate of diffusion has a direct effect on the effectiveness of the finish. In the ion exchange process, the release of the active substances is at a slower rate when compared to direct diffusion and hence has a weaker effect. Similarly, in the case of antimicrobial modifications where the active substances are not released from the fiber surface and so less effective. They are active only when they come in contact with microorganisms.^[15]

Considering the medical, toxicological and ecological principles has developed these so called new technologies. The antimicrobial textiles can be classified into two categories namely passive and active based on their activity against microorganisms. Passive materials do not contain any active substances but their surface structure (Lotus effect) produces negative effect on the living conditions of microorganisms (Anti-adhesive effect). Materials containing active antimicrobial substances act upon either in or on the cell.^[15]

2.5.4 ANTIMICROBIAL SUBSTANCES AND THEIR EFFECT

Many antimicrobial agents used in the textile industry are known from the food stuff and cosmetics sector. These substances are incorporated with textile substrates comparatively at lower concentrations. It must be ensured that these substances are not only permanently effective but also that they are compatible with skin and the environment. A wide palette of antimicrobial compounds is now in use but differ in their mode of action. The following list demonstrates the polyvalent effect of the various antimicrobial substances.

Materials with active finishes contain specific active antimicrobial substances which act upon microorganisms either on the cell, during the metabolism or within the core substance (genome). However, due to the very specific nature of their effect it is important to make a clear distinction between antibiotics and other active substances, which have a broad range of uses.

Oxidizing agents such as aldehydes, halogens and proxy compounds attack the cell membrane, get into the cytoplasm and affect the enzymes of the microorganisms.

Coagulants, primarily alcohols irreversibly denature the protein structures. Radical formers like halogens, isothiazones and peroxy compounds are highly reactive due to the presence of free electrons. These compounds virtually react with all organic structures in particular oxidizing thiols in amino acids. Even at the lowest level of concentrations, these substances pose particular risk to nucleic acids by triggering mutations and dimerization.

One of the most durable type of antimicrobial products is based on a diphenyl ether (bis-phenyl) derivative known as either 2, 4, 4'-trichloro-2' hydroxy diphenyl ether or 5-chloro-2-(2, 4-dichloro phenoxy) phenol. Triclosan products have been used for more than 25 years in hospitals and personal care products such as antimicrobial soap, toothpaste and deodorants. Triclosan inhibits growth of microorganisms by using an electro chemical mode of action to penetrate and disrupt their cell walls. When the cell walls are penetrated, leakage of metabolites occurs and other cell functions are disabled, thereby preventing the organism from functioning or reproducing. The Triclosan when incorporated within a polymer migrates to the surface, where it is bound. Because, it is not water-soluble, it does not leach out, and it continuously inhibits the growth of bacteria in contact with the surface using barrier or blocking action.

Quaternary ammonium compounds, biguanides, amines and glucoprotamine show poly cationic, porous and absorbent properties. Fibres finished with these substances bind microorganisms to their cell membrane and disrupt the lipo poly saccharide structure resulting in the breakdown of the cell.

Complex metallic compounds based on metals like cadmium, silver, copper and mercury cause inhibition of the active enzyme centers (inhibition of metabolism). Amongst these, the silver compounds are very popular and already been used in the preparation of antimicrobial drinking water.

Chitosan is an effective natural antimicrobial agent derived from Chitin, a major component in crustacean shells. Coatings of Chitosan on conventional fibres appear to be the more realistic prospect since; they do not provoke an immunological response. Fibres made from Chitosan are also available in the market place.

Natural herbal products can be used for antimicrobial finishes since, there is a tremendous source of medicinal plants with antimicrobial composition to be the effective candidates in bringing out herbal textiles.^[7]

2.5.5 BENEFITS OF ANTIMICROBIAL TEXTILES

A wide range textile product is now available for the benefit of the consumer. Initially, the primary objective of the finish was to protect textiles from being affected by microbes particularly fungi. Uniforms, tents, defense textiles and technical textiles such as geotextiles have therefore all been finished using antimicrobial agents. Later, the home textiles, such as, curtains coverings and bath mats came with antimicrobial finish. The application of the finish is now extended to textiles used for outdoor, healthcare sector, sports and leisure. Novel technologies in antimicrobial finishing are successfully employed in non-woven sector especially in medical textiles. Textile fibres with built-in antimicrobial properties will also serve the purpose alone or in blends with other fibres. Bioactive fiber is a modified form of the finish, which includes chemotherapeutics in their structure. These fibers are not only used in medicine and health prophylaxis applications but also for manufacturing textile products of daily use and technical textiles. The field of application of the bioactive fibres includes sanitary materials, dressing materials, surgical threads, materials for filtration of gases and liquids, air conditioning and ventilation, constructional materials, special materials for food industry, pharmaceutical industry, footwear industry, clothing industry and automotive industry etc.^[23]

2.5.6 METHODS OF APPLYING ANTIMICROBIAL FINISH

The antimicrobial agents can be applied to the textile substrates by exhaust, dip dry, pad-dry-cure, coating, spray, foam and micro-encapsulation techniques of which only few methods are employed in textile industry.^[5]

2.5.6.1 PAD DRY CURE METHOD

Pad dry cure is a method applying a finish on to the fabric. The agent that has to be finished on to the fabric is diluted using solvents and mixed with cross linking agents to fix the agents into the fabric surface and also to enhance the durability of the finish.

The diluted mixture is taken and padded to the fabric using padding mangle where the fabric roll is fixed to the rollers in the machine left to run for the optimized time. At the same time pH, temperature and concentration are maintained to get an even finishing.^[5]

2.5.6.2 MICROENCAPSULATION

Microencapsulation is a technique to prepare tiny packaged materials called microcapsules that have many interesting features. Substances may be microencapsulated with the intention that the core material be confined within capsule walls for a specific period of time. Alternatively, core materials may be encapsulated so that the core material will be released either gradually through the capsule walls, known as controlled release or diffusion, or when external conditions trigger the capsule walls to rupture, melt, or dissolve.^[29] This technology is mainly used for the purpose of protection, controlled release, and compatibility of the core materials. For this reason widespread interest has developed in microencapsulation technology.^[5]

2.5.6.2.1 BENEFITS OF MICROENCAPSULATION

Microcapsules have a number of interesting advantages and the main reasons for Microencapsulation can be summarized as follows:

- Protection of unstable, sensitive materials from their environments prior to use.
- Better process ability (improving solubility, dispersibility, low ability).
- Self-life enhancement by preventing degradative reactions (oxidation, Dehydration).
- Controlled, sustained, or timed release.
- Safe and convenient handling of toxic materials.
- Masking of odor or taste.
- Enzyme and microorganism immobilization.
- Controlled and targeted drug delivery.
- Handling liquids as solids, reports^[28]

2.5.6.2.2 DIFFERENT APPLICATIONS OF MICRO ENCAPSULATION

There are almost limitless applications for microencapsulated material. Microencapsulated materials are utilized in agriculture, pharmaceuticals, foods, cosmetics and

fragrances, textiles, paper, paints, coatings and adhesives, printing applications, and many other industries.

2.5.7 FIBRES, YARNS AND FABRICS SUITABLE FOR ANTI-MICROBIAL FINISH

2.5.7.1 FIBRES

Fibers are the smallest units of textile fabric and their properties are dependent on their chemical and physical properties. Chemically, the absorbency of the fibres is the important to the transmission mechanism. Highly absorbent fibres remove the liquid therefore halting the movement of the bacteria and trapping it within the fiber structure. When the fibers of low absorbency are present, the liquid will wick along the fiber surface enhancing the capillary movement of bacterial containing liquid.

The physical properties of the surface morphology of the fiber also influence the barrier effectiveness. Fibers with irregular cross section or irregular surfaces have the ability to trap particles as they travel inhibiting particle transmission. Cotton fibres have convulsions ideal for trapping the small particles.^[27]

2.5.7.2 YARNS

The second component of a fabric is yarn, which are produced from fibers. Traditionally yarns are found in woven fabrics but not in non-woven fabrics. Twist is the commonly used to hold fibres together. The lower the twist, bulkier the yarn with increased void between the fibers. These interstitial spaces allow for the trapping of particles. In staple yarns, lower the twist results in protruding fiber ends at the surface of the yarn. These small projections are ideal for trapping small particles. Additionally they create an irregular surface, which disrupts the formation of capillary forces as well as inhibiting the liquid movement.^[27]

2.5.7.3 FABRICS:

Fabric characteristics of importance include pore size characteristics and surface characteristics. Pore size and geometry are determined by fabric construction characteristic. The three primary methods of fabric construction are woven, knitted and non-woven as they are commonly used in medical products.

The most common woven fabric used is plain weave. They have most regular interlacing pattern. The interstices determine the size and geometry of the pores and also contribute to

capillary formation. Thread count is a parameter of the woven fabrics and identifies the number of threads or yarns per inch as the thread count increases, the yarns are closer together resulting in a small pore size but more effective capillaries.^[27]

2.6 NATURAL ANTI MICROBIAL MEDICINAL HERB

Medicinal plants, herbs, spices and herbal remedies are known to Ayurveda in India since long times. The value of medicinal plants, herbs and spices as herbal remedies is being lost due to lack of awareness and deforestation. The result is many valuable medicinal herbs are becoming rare and precious information is lost. Less pollution we make, more ecological balance we maintain, will add to happiness of human kind.

Medicinal herbs are much in demand. Natural herbs are herbs found in the nature, such as found in the forest, along hillside etc. Vitamins and herbs have many correlations, many synthetically produced vitamins and enzymes can be easily found and obtained from the herbs. Healing herbs have healing properties, some times which looks like a miracle.^[53]

2.6.1 NEEM (*AZADIRACHTA INDICA*)

The Sanskrit name of the Neem tree is 'Arishtha' meaning 'reliever of sicknesses. The Neem tree has been described as *A. Indica* as early as 1830 by De Jussieu and its taxonomic position is as follows:

Order	: Rutales
Suborder	: Rutinae
Family	:Meliaceae (mahogany family)
Subfamily	: Melioideae
Tribe	: Melieae
Common name	: <i>Neem</i>
Scientific name	: <i>Azadirachta indica</i> ,reports ^[19,20]

2.6.1.1 Medicinal properties of Neem

Each part of Neem is used in medicines and thus commercially exploitable. Neem has been evaluated for safety and efficacy and after numerous researches by leading organizations and companies, it has been considered as a universal cure for diseases. Medicinal Properties of Neem are listed below:

- Anti-inflammatory
- Anti-arthritis
- Antipyretic
- Hypoglycemic
- Spermicidal
- Antifungal
- Antibacterial
- Diuretic
- Anti-malarial
- Anti-tumor, reports^[64]

2.6.1.2 MEDICINAL USES OF NEEM

- **Neem Bark:** acts as an analgesic and can cure fever.
- **Neem Flower:** Used to cure intestinal problems.
- **Neem Leaf:** Raw leaf and leaf extract can be used for body weight problems, skin problems and ulcers, Dandruff, gastrointestinal problems.
- **Neem Twig:** Can be used to cure common cold and cough, asthma and bronchitis, urinary track disorders, diabetes and blood pressure.
- **Neem Seed:** Can be used to cure leprosy and other gastrointestinal problems.^[64]

2.6.1.3 BENEFITS OF NEEM

The benefits and value of Neem (*Azadirachta Indica*) tree and all its parts do not require any introduction. Their uses in curing and preventing many diseases not only in humans but also in animals have been known to mankind for long. Neem is also used to protect plants from pests and insects; Neem is also used to stimulate the growth of plants as it is considered to be natural manure without any toxic effects.

2.6.1.3.1 NEEM BENEFITS IN HUMAN BEINGS

Neem and its compounds, its extracts and finished products have been known to cure a large number of human ailments. Right from skin diseases to diabetes, from cholesterol to hair

problems, from ulcers to dental problems, the ways in which it affects our lives can not be underestimated. There are many Neem products available in the market in the form of Neem oil, Neem soap, Neem medicines, Neem powder, Neem tea, Neem hair products and so on. Even raw Neem leaves, Neem fruit are also very beneficial to human beings. Some of the benefits of Neem in human beings are as follows:

- Neem works as blood purifier. Consuming raw Neem leaves or Neem leaf powder help in eradicating toxins from the blood.
- It helps in proper healing of wound, burns and injuries.
- Neem is a natural cure for skin diseases. It also provides internal glow to the skin.
- Neem helps our body to combat mild infections.
- Neem also acts as a deworming agent.
- Neem hair oil has proved its importance in treating of hair fall, dandruff, lice and early graying of hairs.
- Neem is helpful in removing dark circles under the eyes.
- Neem helps in treating diabetes.
- Neem is helpful in constipation, indigestion and restoring taste of mouth.
- Neem helps in maintaining proper secretions of liver etc.^[66]

2.6.2 MARIGOLD (*Calendula officinalis*)

2.6.2.1 CLASSIFICATION

Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Asrerales
Family:	Calenduleae
Genus:	Calendula
Scientific Name:	Calendula officinalis

Common name: Garden Marigold, reports ^[45]

2.6.2.2 MEDICINAL PROPERTIES OF MARIGOLD

- Anti-bacterial
- Anti-fungal
- Anti-infective
- Anti-inflammatory
- Anti-oxidant
- Anti-septic
- Anti-spasmodic
- Anti-viral
- Aperient
- Astringent
- Cholagogue
- Detoxifier
- Diaphoretic
- Immenagogue
- Estrogenic
- Haemostatic
- Immuno-stimulant
- Vulnerary, reports ^[12,22]

2.6.2.3 MEDICINAL USES OF MARIGOLD

Marigold is used to treat eczema, scars, cracked skin, rashes, inflammations and viral infections. The petals of Marigold are used to make eyewash. Marigold is also used in both homeopathic and conventional medicine as a healing ointment for cuts and grazes. Marigold can be made into a tea or infusion to help in the healing of mouth ulcers, colitis and stomach ulcers; the infusion works by stimulating the lymphatic system, reducing swelling and cleansing the body of toxins.^[72]

Marigold is used for stomach upset, ulcers, menstrual period problems, eye infections, wound healing. It is antiseptic. When Marigold flower is rubbed on the affected part, it brings relief in pain and swelling caused by a wasp or bee. A lotion made from the flowers is most useful for sprains and wounds and a water distilled from them is good for sore eyes. The infusion of the freshly gathered flowers is beneficial for fever. Marigold flowers are mostly in demand for children ailments.^[45]

Indicated for: Acne, athlete's foot, blepharitis, candida, cold sores, conjunctivitis, coughs, cramps, eczema, fungal infections, gastritis, good digestion, haemorrhoids, HIV, menopausal symptoms, menstrual cramps, minor burns, phthiriasis (dry), relieving colitis, ringworm, sore throats, skin ulcerations, snake bites, sprains, sunburns, varicose veins, viral infections, warts, wounds.^[22]

2.7 MEDICAL PRODUCTS – DEFINITION

Any substance or combination of substances presented for treating or preventing disease in human beings or animals. Products for which (explicitly or implicitly) claims to cure, alleviate or prevent disease are made will be considered as medicinal products.

2.7.1 HERBAL MEDICATED PRODUCTS

Herbal medicinal products are defined as any medicinal product, exclusively containing as active ingredients one or more herbal substances or one or more herbal preparations, or one or more such herbal substances in combination with one or more such herbal preparations.

The use of textile materials for medical and healthcare products can be classified into following main areas –

- Barrier material (for infection control)
- Bandaging & pressure garment
- Wound care material
- Implantable material (sutures, Joints etc)
- Extra Corporal devices (Kidney)

Healthcare & Hygiene

Includes products like –

- Surgical / wound dressings
- Gowns / drapes
- Diapers / femcare pads / adult incontinence diapers
- Bedsheets / curtains / Towels / Mitts / Wipes, reports^[6]

METHODOLOGY

3. METHODOLOGY

3.1 SELECTION OF MATERIAL

3.1.1 Cotton

Cotton is a cool, soft, comfortable, the principal clothing fiber of the world. Its production is one of the major factors in world prosperity and economic stability. ^[49]

Cotton is the world's most important apparel fiber. With a long history, it has endured because of its unique properties that make it ideal for much of the clothing we wear. Cotton is attractive, durable and comfortable fabric which has proven itself countless times to be a superior fiber for clothing manufacturing. Cotton absorbs the moisture from your skin allowing it to evaporate by passing through the fabric, thus allowing your body to regulate your temperature. ^[60] This fiber absorbs and releases perspiration quickly and makes the fabric to "breathe". Boiling and sterilizing temperatures can also be used on cotton without disintegration. It can also be ironed at relatively high temperatures, stands up to abrasion and wears well. ^[49]

3.2 SELECTION OF NATURAL MEDICINAL HERBS

Medicinal herbs are the local heritage with global importance. Medicinal herbs have curative properties due to presence of various complex chemical substance of different composition which are found as secondary plant metabolites in one or more parts of these plants. These plant metabolites according to their composition are grouped as alkaloids, glycosides, corticosteroids, essential oils etc. ^[74] The herbal treated garments are anti-allergic, anti-microbial and have anti-septic properties and dyes used are eco-friendly which benefit children and the future generations by stopping Air, Water and Soil pollution.

3.2.1 NEEM

Neem leaves have anti-bacterial properties which help in treating skin problems. ^[65] Neem tree and its compounds, its extracts and finished products have been known to cure a large number of human ailments. Right from skin diseases to diabetes, from cholesterol to hair problems, from ulcers to dental problems, even raw Neem leaves, Neem fruit are also very beneficial to human beings. Some of the benefits of Neem tree in human beings are as follows:

Neem works as blood purifier. Consuming raw Neem leaves or Neem leaf powder helps in eradicating toxins from the blood. This is one of the greatest benefits of Neem tree.

- It helps in proper healing of wound, burns and injuries.
- Neem is a natural cure for skin diseases. It also provides internal glow to the skin.
- Neem helps our body to combat mild infections.
- Neem also acts as a deworming agent.
- Another Neem plant benefits include removal of dark circles under the eyes and skin infections, reports^[66]

3.2.2 MARIGOLD

Marigold has a long history as a superior antibacterial when used internally and externally and has been used to heal many skin irritations, wounds, and injuries, including Eczema, herpes, gingivitis.

Due to its natural iodine content it used as a local application to heal all types f skin problems. Some consider Marigold to be the best tissue healer for wounds.

Marigold enhance the production of collagen in the skin and fill in facial Wrinkles, tone tender skin, treat Sunburn and insect bites, and protect babies' sensitive skin (particularly when used for diaper rash).^[52]

The medicinal value of the marigold is largely because of the anti-fungal and anti-septic properties. Marigold is often used by aroma therapists to cure many diseases like viral infections, eczema, cracked skin, scars, inflammation and rashes. ^[69]

3.3 SELECTION OF SOLVENT

Water, Ethanol, Methanol, Hexane are selected as solvents for dry extraction method. Solvents are selected based on their polarity ranging from lower polar to high polar. Hexane is a low polar solvent and the compound that has affinity to those polar particles gets separated. Some compounds will get separated only when high polar substances are used and harsh treatments like heating are carried out.

3.4 SELECTION OF SUITABLE EXTRACTION METHOD

The extraction method used in this project is dry extraction process:

3.4.1 DRY EXTRACTION PROCESS FOR NEEM

The Neem leaves are taken from the Neem tree and sorted. The leaves are then allowed to dry in shade for 4-5 days. The dried leaves are powdered.

5gms of the Neem powder is taken in a conical flask and 50ml of solvent (Ethanol, Methanol, Hexane, Acetone and Water) is added to it. Then cotton is plugged into the head of the conical flask and wrapped with the paper so that the evaporation of the solvent is prevented. Then it is kept inside the shaker for 24hrs.

After 24hrs, the extract is taken from the shaker and filtered into a beaker using a filter paper, so that we get the extract solution from it which is used for the further process. Then this extract solution is poured into the Petri plate and kept in the oven for 4-5 hrs for evaporating the solvent from it.

The dried extract is taken and the powder is scrapped from the plate and diluted with water to get the exact extraction solution.

3.4.2 DRY EXTRACTION PROCEES FOR MARIGOLD

The marigold flowers are taken and sorted. The flowers are then allowed to dry in shade for 4-5 days. The dried flowers are powdered.

5gms of the Marigold powder is taken in a conical flask and 50ml of solvent (Ethanol, Methanol, Hexane, Acetone and Water) is added to it. Then cotton is plugged into the head of the conical flask and wrapped with the paper so that the evaporation of the solvent is prevented. Then it is kept inside the shaker for 24hrs.

After 24hrs, the extract is taken from the shaker and filtered into a beaker using a filter paper, so that we get the extract solution from it which is used for the further process. Then this extract solution is poured into the Petri plate and kept in the oven for 4-5 hrs for evaporating the solvent from it.

The dried extract is taken and the powder is scrapped from the plate and diluted with water to get the exact extraction solution.

3.5 OPTIMIZATION OF PROCESS CONDITIONS

The optimization of the process conditions are done by using the L₁₆ Orthogonal design table which is given below:

TABLE-1

OPTIMIZATION OF PROCESS CONDITIONS – L₁₆ ORTHOGONAL DESIGN TABLE

LEVELS	PARAMETERS		
	A	B	C
	Time (mins)	Temp (in °c)	Concentration(in%)
1	30	40	25
2	60	50	50
3	90	60	75

L₁₆ ORTHOGONAL DESIGN OF EXPERIMENT(Xu et al., 2007)

TABLE-2

ORTHOGONAL DESIGN OF EXPERIMENT

Exp.	A	B	C
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	3
5	2	2	1
6	2	3	2
7	3	1	2
8	3	2	3
9	3	3	1

The process conditions are optimized based on the orthogonal design by taking the extract in the different concentrations like (25%, 50%, 75%) in the beaker, time limit as 30mins, 60mins, 90mins and the different temperatures like (40° C, 50 ° C, 60°C) are maintained by keeping the beakers in the water bath for the nine conditions given in the Orthogonal design table. Then the fabric is treated with the extraction which is maintained under the conditions and then the Agar diffusion method is carried out. The organism used in for identifying the microbial growth in this optimization process is *Proteus Vulgaris* Bacteria.

From the optimization results and the zone of inhibition of microbial growth, the solvent water, 50% herbal extracts, temp-50°C, and time 30mins has been chosen as the best process conditions to be followed to finish the final product. This condition is suitable for both Neem and Marigold. [36]

3.6 SELECTION OF SUITABLE MORDANT

Mordant are substances which are used to fix a dye to the fibers. They also improve the take-up quality of the fabric and help improve color and light-fastness. The term is derived from the Latin *mordere* to bite. Some natural dyes for example, indigo will fix without the aid of a mordant and these dyes are known as ‘substantive dyes’. [73]

Recently, interesting natural mordents is arisen, due to their eco-friendly and non-carcinogenic nature. The natural mordant such as myrobalan, pomegranate rinds, tannin, tannic acid, tartaric acid, guava and banana leaves are being utilized for mordanting purpose. [14]

The mordant creates a link between the dyestuff and the fiber – it remains in the fiber permanently holding the dye. The mordant allows a dye to attain acceptable wash fastness. [67] Pomegranate is one of the most largely consumed fruits in Asia. The dye is extracted from its fruit rind. The color obtained exhibit good fastness to washing rubbing and light. At times this dye is also used as mordant and is over dyed with other Natural Dye to improve fastness of later. [38] And hence due to these properties, in our process we have used pomegranate as a mordant.

3.7 SELECTION OF FINISHING APPLICATION METHOD ON FABRIC

- There are two methods of fabric application:

1. Pad – dry – cure Method
2. Microencapsulation Method

3.7.1 PAD – DRY – CURE FINISH APPLICATION METHOD

The fabric samples were treated with herbal extract using pomegranate extract solution (mordant) as cross linking agent. Extracts of neem and marigold were applied on to the fabric by using the padding mangle with the below mentioned conditions.

- Material liquor ratio=1:10
- Temperature=50° C
- Pressure=20pascal
- Time =30min

After padding the samples were taken and dried at 60° C for 5min.^[30]

3.7.2 MICROENCAPSULATION METHOD

Microencapsulation was done using Neem and marigold extract as a core material and gum acacia as a wall material 50gm of wall material was allowed to swell for half an hour by mixing with 500ml of hot water. To this mixture 250ml of hot water was added, stirred for 15min maintaining the temperature between 40°C and 50°C 500millilitre of core material was added and stirred at 300-500rpm for further 15min followed by drop wise addition of 20% sodium sulphate solution(250ml) for 5 to 10min.The stirrer speed was reduced and then 125ml of 17% formaldehyde was added. The stirrer was stopped and the mixture was freeze-dried. The cotton fabric was immersed in the microcapsule solution using pneumatic padding mangle, squeezed and then dried at 60-70°C in an oven.^[30]

3.8 SELECTION OF MICRO ORGANISMS

All microorganisms are living things (or) organisms. Microorganisms require food, air, water, ways to dispose of waste and an environment in which they can live. Some microorganisms are producers living things that make their own food from simple substances usually using sunlight, as plants do. Some microorganisms eat other organisms to get their food. [75]

Microorganisms have a direct impact on our daily lives. Some are helpful. They aid our bodily processes by helping break down complex foods into simpler substances. Some, called germs, are harmful to us by the role they play in causing diseases. [76]

3.8.1 SELECTED MICRO ORGANISMS

3.8.1.1 BACTERIA

- *Gram positive bacteria:* Staphylococcus aureus
- *Gram negative bacteria* Escherichia coli

3.8.1.2 FUNGI

- Aspergillus Niger

3.9 SELECTION OF ANTI BIOTICS

The anti biotic are chosen based on the type of bacteria's and fungi used.

- Penicillin Anti-biotic for Staphylococcus aureus
- Chloramphenicol Anti-biotic for Escherichia coli

3.10 EVALUATION METHODS

PRELIMINARY TESTS FOR ANTI MICROBIAL COMPOUNDS

3.10.1 THIN LAYER CHROMOTOGRAPHY TEST:

Thin layer chromatography (TLC) is a chromatography technique used to separate mixtures.^[11] Thin layer chromatography is performed on a sheet of glass, plastic, or aluminum foil, which is coated with a thin layer of adsorbent material, usually silica gel, aluminium oxide, or cellulose (blotter paper). This layer of adsorbent is known as the stationary phase.

the sample has been applied on the plate, a solvent or solvent mixture (known as the mobile phase) is drawn up the plate via capillary action. Because different analyses ascend the TLC plate at different rates, separation is achieved.^[34]

Thin layer chromatography can be used to:

- Monitor the progress of a reaction
- Identify compounds present in a given substance
- Determine the purity of a substance

Specific examples of these applications include:

- analyzing ceramides and fatty acids
- detection of pesticides or insecticides in food and water
- analyzing the dye composition of fibers in forensics, or
- assaying the radiochemical purity of radiopharmaceuticals
- identification of medicinal plants and their constituents^[24]

3.10.2 FOURIER TRANSFORM – INFRARED SPECTRA (FT-IR)

One of the important applications of the infrared spectroscopic study is the diagnostic value in establishing the presence of certain organic constituents in plants. ^[32]FT-IR spectroscopy provides more detailed chemical information on the samples composition because it measures the fundamental vibration. More recently FT-IR has been introduced as a metabolic

fingerprinting tool for the plant sciences. ^[33] In such an attempt, either a frequency shift or the variation of the intensity of some characteristic absorption bands can be of some use. From the treated fabric sample, compounds responsible for the antimicrobial property are identified and quantified by the FT-IR analysis. ^[17] The FT-IR table is given in Appendix -9.

3.11 ANTI MICROBIAL TEST METHODS

3.11.1 ANTI-BACTERIAL TESTING - (AATCC 147- 1988 (USA) QUALITATIVE)

Organism Used: *Staphylococcus aureus*, *Escherichia coli*.

Procedure: For both *Staphylococci aureus* and *Escherichia coli*

2.8gms of Nutrient Agar is weighed and added to 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 Petri plates should be cleaned well and wrapped in a paper. The Nutrient Agar and the Petri plates should be Autoclaved at a temperature of 121°C for 15 mins.

The laminar air flow chamber is cleaned with ethanol and then the sterilized Agar and plates should be kept inside the chamber. The tips used for pipette out the bacteria should also be sterilized.

The Agar was then poured onto the Petri plates and it is allowed to solidify. The Petri plates are kept on the turn table and 100µl of **staphylococci aureus** bacteria is pipette out and poured in the solidified Agar. Using the L-rod the bacteria is spread evenly with the help of turn table. Similarly the 100µl of **Escherichia coli** bacteria is pipette out and poured in the solidified Agar. Using the L-rod the bacteria is spread evenly with the help of turn table.

Then the well is cut on the Agar. Then the extraction solution is pipette out in the concentration of 50µl and 100µl. Also **Penicillin Anti-biotic and Chloramphenicol Anti-biotic** is placed on the Agar to check its inhibition. Then it is kept in the incubator at 38°C for 12 hrs.

After 12hrs, the zone of inhibition is seen clearly in the plates and it is measured. Higher the zone of inhibition higher is the Anti-Bacterial activity.

3.11.2 ANTIFUNGAL TESTING - (AATCC 30 QUALITATIVE)

Organism Used: Aspergillus Niger

Procedure:

2.8gms of Nutrient Agar is weighed and added to 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 Petri plates should be cleaned well and wrapped in a paper. The Nutrient Agar and the Petri plates should be Autoclaved at a temperature of 121°C for 15 mins.

The laminar air flow chamber is cleaned with ethanol and then the sterilized Agar and plates should be kept inside the chamber. The tips used for pipette out the fungi should also be sterilized.

The Agar is then poured onto the Petri plates and it is allowed to solidify. The Petri plates are kept on the turn table and 100µl Aspergillus Niger fungi of is pipette out and poured in the solidified Agar. Using the L-rod the fungi is spread evenly with the help of turn table.

Then the fabric is dipped in the extraction solution and it is placed on the Agar to check its inhibition. Then it is kept in the incubator at 38°C for 12 hrs.

After 12hrs, the zone of inhibition is seen clearly in the plates and it is measured. Higher the zone of inhibition higher is the Anti-Fungal activity.

3.12 OBJECTIVE EVALUATION

Objective evaluation tests are carried out by laboratory examination by using various instruments, to study the various physical properties of the fabric before and after the finishing treatment.

3.12.1 FABRIC PARTICULARS

- GSM of the fabric=63
- EPI (ends per inch) = 82
- PPI(picks per inch) = 66

- FABRIC COUNT: 60^s

3.12.2 FABRIC TENSILE STRENGTH – (ASTM D5305)

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 of the fabric and the usage of the fabric.

Procedure

Spread the given fabric sample on the table. Remove the selvedge and wrinkles from the fabric. Prepare samples of size 15*2.5cm are cut from the lot. 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 and 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 reading from the computer.

3.12.3 FABRIC ABRASION RESISTANCE – (ASTM D 4966)

MACHINE USED: MARTINDALE ABRASION TESTER

Principle: Two simple harmonic motions working at right angles.

Procedure

Prepare sample of 38mm diameter. The initial weight of the sample is found using electronic balance. Fix the sample in the mushroom shaped sample holder. Fix the mushroom shaped sample holder in the machine in such a way that the samples are exposed to abrading material (emery paper) Select a suitable weight(200gm) and place it on the sample holder. Start and run the machine for 50 cycles. Remove the sample holder from the machine and remove the sample from the sample holder.

- Calculate the weight loss and abrasion resistance from the given formulae:

Initial Wt-Final Wt

$$\text{weight loss} = \frac{\text{Initial Wt} - \text{Final Wt}}{\text{Initial Wt}} * 100$$

$$\text{Abrasion Resistance} = 100 - \text{Weight loss}\%$$

3.12.4 FABRIC STIFFNESS – (ASTM D 1388)

Principle: Cantilever principle

Procedure:

Prepare sample from the given fabric in warp and weft direction. 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. Push both the template and fabric in forward direction. The fabric will tend to drop at the edge on its own weight. Stop moving the fabric and if the tip of the fabric cuts the index lines engraved in the side wall of the instrument when viewed in mirror. Record the reading from the template.

• **Formulae:**

$$\text{Weight of the fabric}(W_2) = \text{g/cm}^2$$

$$\text{Flexural Rigidity}(G) = W_2 * C^3 * 10^3 \text{ mg.cm}$$

$$\text{Overall flexural rigidity} = \sqrt{G_1 * G_2}$$

$$\text{Bending Modulus (Q)} = \frac{12G * 10^{-6}}{g^3} \text{ kg/sq.cm}$$

Where g=thickness in cm.

3.12.5 FABRIC THICKNESS – (ASTM D 1777)

Principle

The fabric is kept between the two plane parallel plates and a known arbitrary pressure is 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 gauge is set to read zero. No specimen preparation is required. But the selvages and the creased areas should be avoided. If possible, the cloth may be conditioned for about 24 hours in standard atmosphere. At least, thickness is measured at 5 different places and the mean value is reported.

3.12.6 FABRIC DRAPE

Procedure

Prepare a sample of the required size. Open the transparent lid of the drape meter. Fix the sample over the bottom supporting disc. Place the top supporting disc and secure it by tightening the screw. 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. Close the lid and place a white paper over the lid. Switch on the light. Draw the outline of the projected and area of the specimen. Calculate the drape coefficient from the formulae.

$$\text{Drape coefficient(\%)} = \frac{W_s - W_d}{W_D - W_d} * 100$$

Where W_D =cut of the paper whose area is equal to the area of the specimen.

W_d =weight of paper whose area is equal to the area of the supporting disc

W_s =weight of paper whose area is equal to the projected area of specimen

3.12.7 WICKING TEST

Procedure

Prepare the required fabric specimen of size 10*2cm. Suspend the specimens vertically with its ends dipping into the solution. Observe the effect at different heights and time of absorption.

3.13 SEM STUDY

The morphology of microcapsule-treated fabric was analyzed using high-resolution scanning electron microscope with suitable accelerating voltage and magnifications. The scanning electron microscopy was used for confirming the binding of microcapsules and alignment onto the fabric samples.

The presence, binding and availability of microcapsules on the fabric were analyzed using scanning electron microscopy. The SEM photographs are shown in figure at different magnification levels. It's clear that the microcapsules are present in the interstices of the fiber assembly of fabric.^[19]

3.14 CONSTRUCTION PROCEDURE

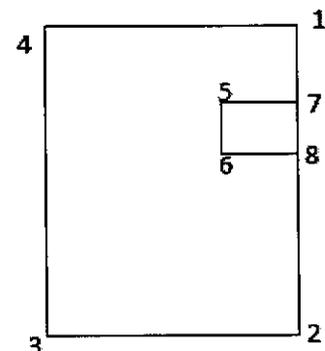
3.14.1 MASK

Measurements: height of the mask, circumference of the head.

Procedure:

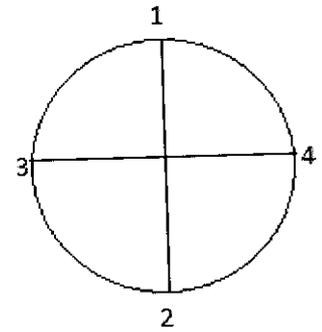
SIDE PIECE:

Draw a rectangle 1234, where 1-2 is the height of the mask (top of the head to neck). 2-3 is the $\frac{1}{2}$ of the circumference of the head. Mark 3-4 same as 1-2 and mark 1-4 same as 2-3. Mark 1-7 = 3", 7-8 = 4", 6-8 = 2". Mark 5-6 same as 7-8 and mark 5-7 same as 6-8. Join 5,6,7,8.



TOP PIECE:

Mark 1-2 length of the top of the head, mark 3-4 as the width of top of the head. Join 1,2,3,4 as a circle as shown in the figure.

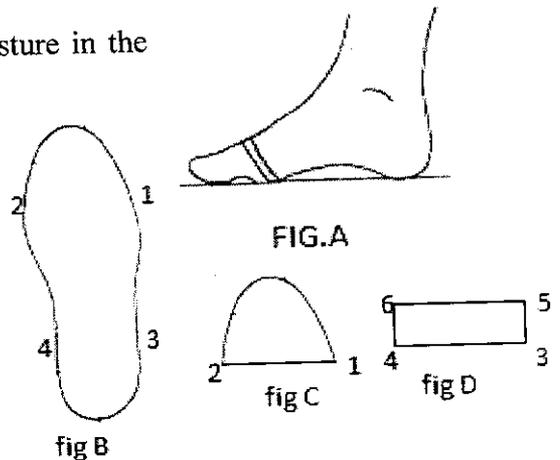


FOOT WEAR

To trace the base of the footwear, the posture in the fig.A can be used. Trace the base as in fig.B.

Mark 1 & 2 from the base for the front piece as shown in the fig C.

Mark 3 & 4 from the base for the back piece as shown in the fig D. Mark 4-6 as 2" (height of the back piece). Mark 5-3 same as 4-6. Mark 5-6 same as 3-4.



3.15 WEAR STUDY

3.15.1 Selection of persons:

NEEM: Dandruff Patients, persons with pimples

MARIGOLD: Home Makers, Sports Persons

3.15.2 Selection of products:

Products like mask and foot band that are made up of cotton woven fabric and finished with the herbal extracts and is used for the wear study.

Neem: face and head mask for dandruff and pimples.

Marigold: foot band for cracked skin and athlete foot.

3.15.3 Selection of hospital: Indian Ayurvedic Hospital and Research Limited, Coimbatore

3.15.4. Wear study period: 15 days

3.16. WASH DURABILITY TEST

Procedure:

The treated fabric is hand washed using the commercial detergent such as 1, 3, and 5,10,15,20 washes and dried. Then the fabric is categorized according to their washes and checked for anti microbial activity.

2.8gms of Nutrient Agar is weighed and added to 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 Petri plates should be cleaned well and wrapped in a paper. The Nutrient Agar and the Petri plates should be Autoclaved at a temperature of 121°C for 15 mins.

The laminar air flow chamber is cleaned with ethanol and then the sterilized Agar and plates should be kept inside the chamber. The tips used for pipette out the bacteria should also be sterilized.

The Agar is then poured onto the Petri plates and it is allowed to solidify. The Petri plates are kept on the turn table and 100µl staphylococcus Aureus bacteria and Escherichia coli bacteria is pipette out and poured in the solidified Agar. Using the L-rod the bacteria is spread evenly with the help of turn table.

Then the washed fabric is placed on the Agar to check its inhibition. Then it is kept in the incubator at 38°C for 12 hrs.

After 12hrs, the zone of inhibition is seen clearly in the plates and it is measured. Higher the zone of inhibition higher is the Anti-bacterial activity.

3.16 FEED BACK

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

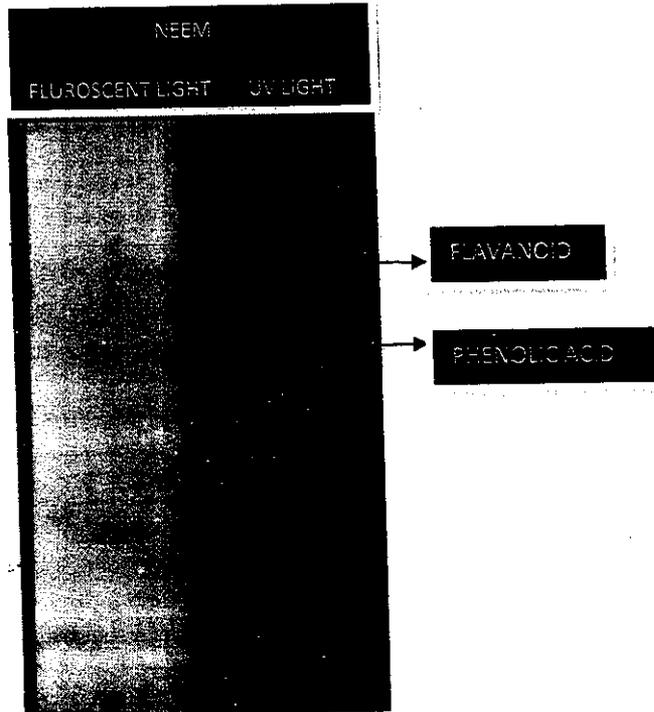
RESULTS AND DISCUSSION

4 .RESULTS AND DISCUSSION

4.1 PRELIMINARY ANTIMICROBIAL ASSESSMENT TESTS

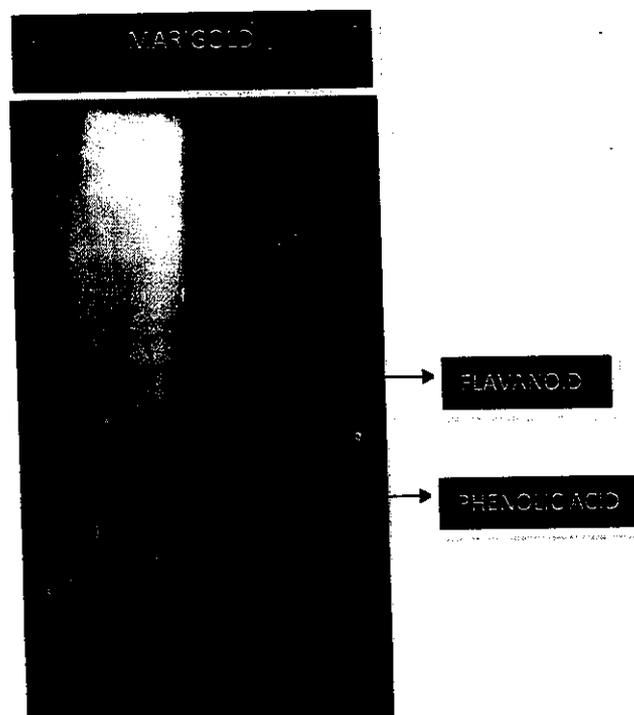
4.1.1 THIN LAYER CHROMATOGRAPHY(TLC)

4.1.1.1 NEEM



From this test we incur that the Neem consists of compounds such as flavanoid compound and phenolic acid in it. In UV light, the dark brownish shade indicates the flavanoid compound and the blue shade indicates the phenolic acid.

4.1.1.2 MARIGOLD



From this test we incur that the Marigold consists of compounds such as flavanoid compound and phenolic acid in it. In UV light, the dark brownish shade indicates the flavanoid compound and the blue shade indicates the phenolic acid.

4.1.2 FOURIER TRANSFORM – INFRA RED SPECTRA (FT – IR)

From the treated fabric sample, compounds responsible for the antimicrobial property are identified and quantified by the FT-IR analysis which is mentioned in APPENDIX 8

TABLE - 3
Infrared absorption frequencies of untreated and treated cotton (cellulose)

Literature	Peaks obtained (cm^{-1})			Peak characteristics
	Experimental			
	Untreated cotton fabric (reflectance mode)	Neem Treated fabric (reflectance mode)	Marigold treated fabric (reflectance mode)	
3,570–3,200	3,437	3,433 and 3,240	3,433 and 3,363	H bonded OH stretch
3,000–2,800		2,970	2,970	C–H stretching
1,711	1,716	1,712	1,712	C=O stretch in –COOH
1,373	1,365	1,373	1,373	CH bending (deformation stretch)
1,204	1,219	1,219	1,219	OH in-plane bending
1,092	1,080	1,080	1,087	Asym. in-plane ring stretch

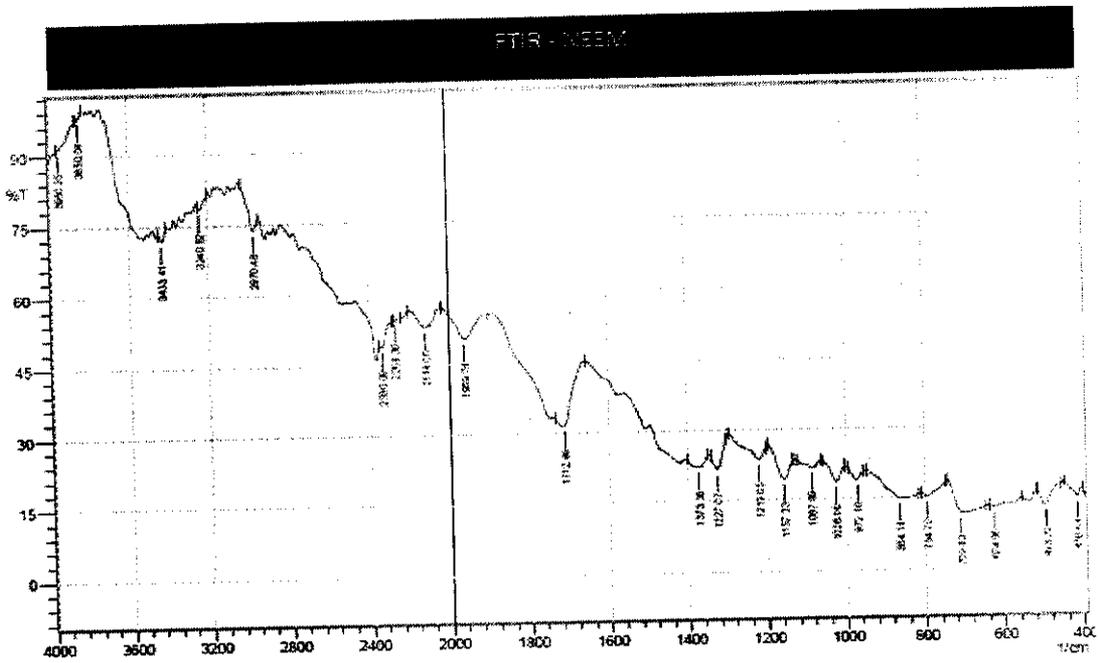


FIGURE 1 - FTIR ANALYSIS – NEEM

Thus from the FTIR result, we found that the Neem herb possess the anti-microbial compounds in it, which inhibits the growth of bacteria and fungi.

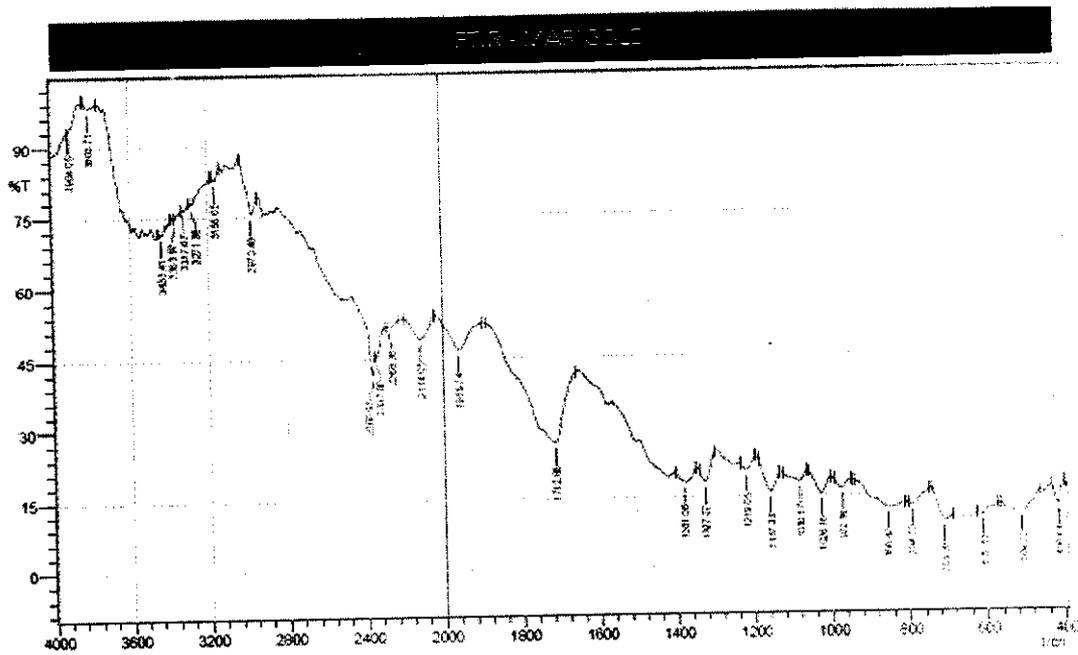


FIGURE 2 - FTIR ANALYSIS - MARIGOLD

Thus from the FTIR result, we found that the Marigold herb possess the anti-microbial compounds in it, which inhibits the growth of bacteria and fungi.

4.2 ANTI MICROBIAL TESTS

4.2.1 ANTI BACTERIAL ACTIVITY (SOLVENT IDENTIFICATION TEST)

4.2.1.1 NEEM – AATCC 147 – AGAR DIFFUSION TEST – POSITIVE BACTERIA (Zone of inhibition)

TABLE - 4

NEEM – AATCC 147 – AGAR DIFFUSION TEST – (STAPHYLOCOCCUS AUREUS)

HERBS	ANTIBIOTIC Penicillin (mm)	CONCENTRATION OF HERB SOLUTION(μl)	METHANOL (mm)	ETHANOL (mm)	WATER (mm)
NEEM	42	50	17	19	19
		100	16	20	21

From the above table, we conclude that solvent water has more zone of inhibition when compared to other solvents and also it satisfies the economics aspects for the further process to be carried out. The best zone of inhibition is taken by comparing the zone with the antibiotic's zone of inhibition.

4.2.1.2 NEEM – AATCC 147 – AGAR DIFFUSION TEST – NEGATIVE BACTERIA BACTERIA (ESCHERICHIA COLI)

TABLE-5

NEEM – AATCC 147 – AGAR DIFFUSION TEST – BACTERIA (ESCHERICHIA COLI)

HERBS	ANTIBIOTIC chloramphenicol (mm)	CONCENTRATION OF HERB SOLUTION(μl)	METHANOL (mm)	ETHANOL (mm)	HEXANE (mm)	WATER (mm)
NEEM	27	50	21	24	-	24
		100	26	27	-	28

It is evident that from the above table, the solvent water has more zone of inhibition when compared to other solvents and also it satisfies the economics aspects for the further process to be carried out. The best zone of inhibition is taken by comparing the zone with the antibiotic's zone of inhibition.



P-3590

Thus from the two different bacteria usage, the Escherichia coli has more zone of inhibition than staphylococcus aureus which prevents the growth of bacteria.

4.2.1.3 MARIGOLD – AATCC 147 – AGAR DIFFUSION TEST – POSITIVE BACTERIA (Zone of inhibition)

TABLE -6

MARIGOLD – AATCC 147 – AGAR DIFFUSION TEST (STAPHYLOCOCCUS AUREUS)

HERBS	ANTIBIOTIC Penicillin (mm)	CONCENTRATION OF HERB SOLUTION(μ l)	METHANOL (mm)	ETHANOL (mm)	WATER (mm)
MARIGOLD	39	50	16	17	17
		100	21	23	24

Thus from the above table, we conclude that water has more zone of inhibition when compared to other solvents and also it satisfies the economics aspects for the further process to be carried out. The best zone of inhibition is taken by comparing the zone with the antibiotic's zone of inhibition.

4.2.1.4 MARIGOLD – AATCC 147 – AGAR DIFFUSION TEST – NEGATIVE BACTERIA (Zone of inhibition)

TABLE- 7

MARIGOLD – AATCC 147 – AGAR DIFFUSION TEST (ESCHERICHIA COLI)

HERBS	ANTIBIOTIC chloramphenicol (mm)	CONCENTRATION OF HERB SOLUTION(μ l)	METHANOL (mm)	ETHANOL (mm)	HEXANE (mm)	WATER (mm)
MARIGOLD	27	50	18	19	16	19
		100	21	23	20	24

Thus from the above table, we conclude that water has more zone of inhibition when compared to other solvents and also it satisfies the economics aspects for the further process to be carried out. 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 more zone of inhibition than Staphylococcus Aureus which prevents the growth of bacteria.

4.3 OPTIMISATION OF PROCESS PARAMETERS

4.3.1 NEEM

TABLE- 8

OPTIMIZATION OF PROCESS PARAMETERS - NEEM

TIME (mins)	TEMPERATURE (°C)	CONCENTRATION OF HERB (ml)	ZONE OF INHIBITION (mm)
30	40	2.5	21
30	50	5	19
30	60	7.5	19
60	40	7.5	20
60	50	2.5	20
60	60	5	19
90	40	5	18
90	50	7.5	16
90	60	2.5	16

The time, temperature and concentration have been optimized based on the orthogonal design and the best result is taken (40°C, 30mins, and 2.5ml) for the further process depending on the zone of inhibition and the economic aspects.

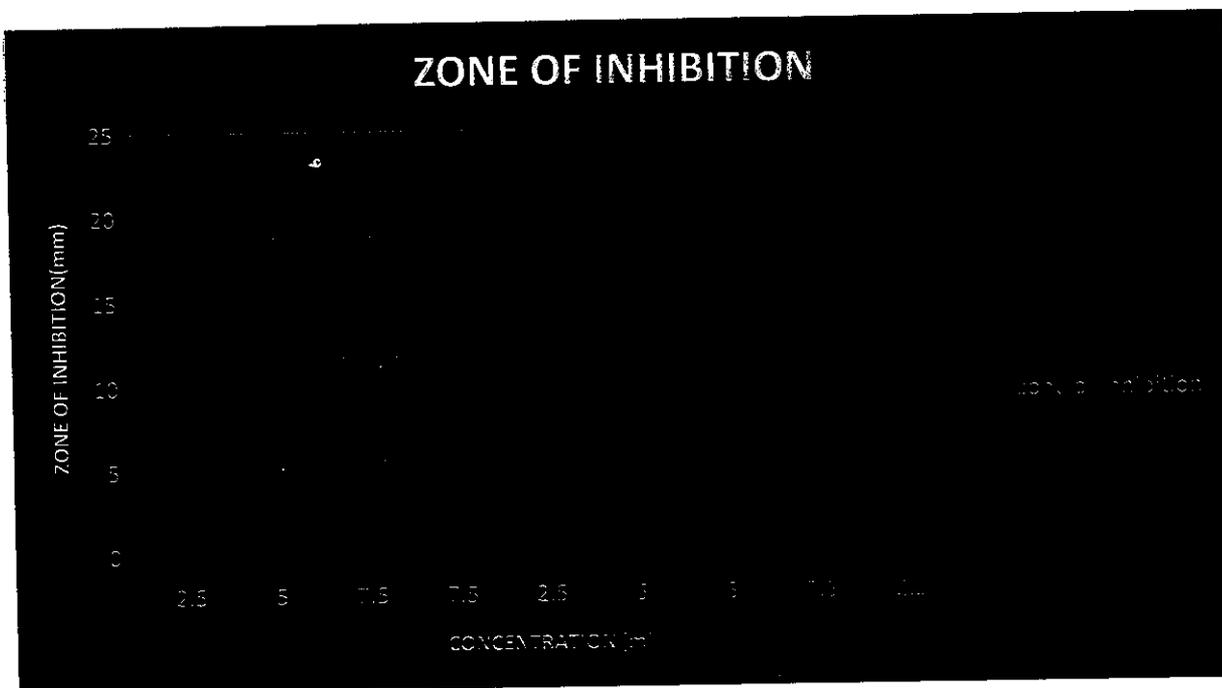


FIGURE – 3 - OPTIMIZATION OF PROCESS PARAMETERS - NEEM

4.3.2 MARIGOLD

TABLE- 9

OPTIMIZATION OF PROCESS PARAMETERS - MARIGOLD

TIME (mins)	TEMPERATURE (°C)	CONCENTRATION OF HERB (ml)	ZONE OF INHIBITION (mm)
30	40	2.5	17
30	50	5	22
30	60	7.5	25
60	40	7.5	25
60	50	2.5	23
60	60	5	22
90	40	5	20
90	50	7.5	24
90	60	2.5	23

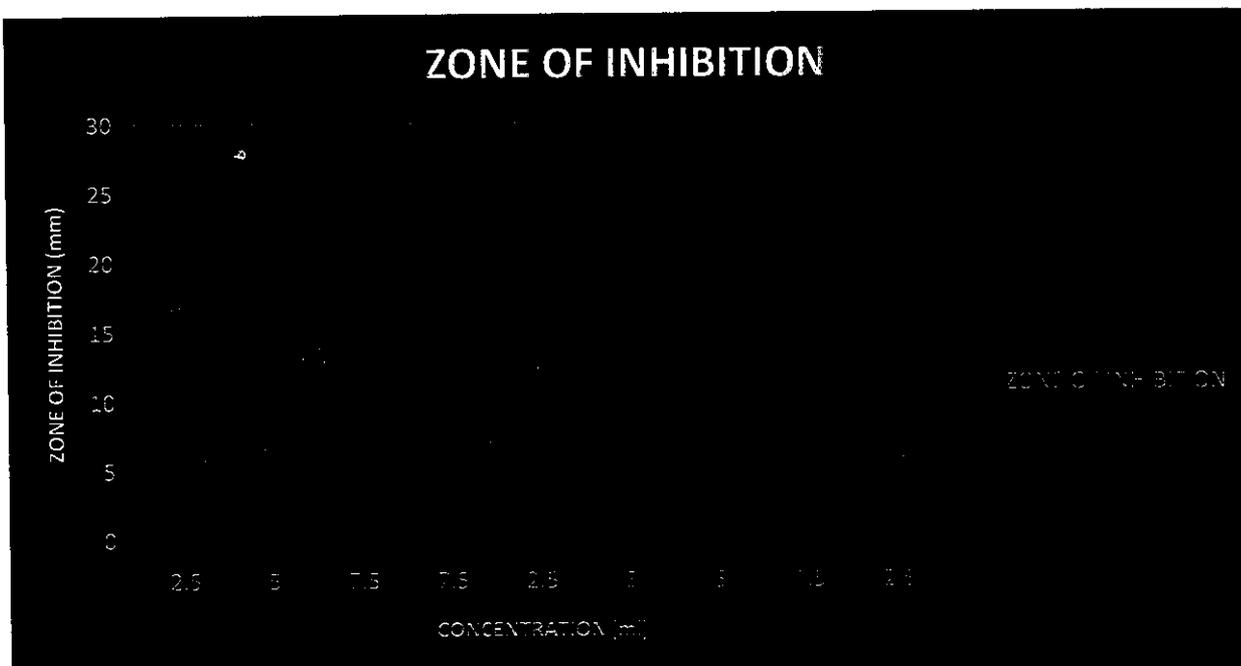


FIGURE – 4 - OPTIMIZATION OF PROCESS PARAMETERS - MARIGOLD

The time, temperature and concentration have been optimized based on the orthogonal design and the best result is taken (60°C, 30mins, and 7.5ml) for the further process depending on the zone of inhibition and the economic aspects.

4.4 ANTI FUNGAL ACTIVITY

4.4.1 NEEM – AATCC 30 QUALITATIVE – AGAR DIFFUSION TEST - FUNGI

TABLE- 10

NEEM – AATCC 30 QUALITATIVE – AGAR DIFFUSION TEST- FUNGI (ASPERGILLUS NIGER)

HERB	CONCENTRATION (ml)	(zone of inhibition)
NEEM	2.5	18mm

The best optimized condition is selected from the optimization process and by using that condition. AATCC 30 test has been carried out and checked for the zone of inhibition as in the above table.

4.4.2 MARIGOLD - AATCC 30 QUALITATIVE – AGAR DIFFUSION TEST - FUNGI

TABLE- 11

MARIGOLD - AATCC 30 QUALITATIVE – AGAR DIFFUSION TEST - FUNGI (ASPERGILLUS NIGER)

HERBS	CONCENTRATION (ml)	(zone of inhibition)
MARIGOLD	7.5	20mm

The best optimized condition is selected from the optimization process and by using that condition AATCC 30 test has been carried out and checked for the zone of inhibition as in the above table.

4.5 OBJECTIVE EVALUATION

4.5.1 FABRIC TENSILE STRENGTH

4.5.1.1 NEEM

TABLE-12

FABRIC TENSILE STRENGTH-UNTREATED FABRIC

SL.NO	TENSILE STRENGTH	BREAKING FORCE	TENSILE STRENGTH	BREAKING FORCE
	WARP DIRECTION		WEFT DIRECTION	
1	6.10	7.40	5.00	8.80
2	9.30	11.60	6.20	11.10
3	8.30	9.90	5.20	10.10
4	10.20	12.10	5.70	10.80
5	9.40	11.50	5.80	10.10
MEAN	8.66	10.50	5.58	10.18

TABLE- 13**FABRIC TENSILE STRENGTH - NEEM TREATED FABRIC (PADDING)**

SL.NO	TENSILE STRENGTH	BREAKING FORCE	TENSILE STRENGTH	BREAKING FORCE
	WARP DIRECTION		WEFT DIRECTION	
1	6.80	8.30	2.80	3.70
2	5.50	5.70	4.30	8.00
3	9.20	10.00	3.00	4.70
4	12.10	12.90	3.10	4.70
5	9.10	10.90	3.40	6.10
MEAN	8.54	9.56	3.32	5.44

TABLE- 14**FABRIC TENSILE STRENGTH - NEEM TREATED FABRIC (MICRO ENCAPSULATION)**

SL.NO	TENSILE STRENGTH	BREAKING FORCE	TENSILE STRENGTH	BREAKING FORCE
	WARP DIRECTION		WEFT DIRECTION	
1	6.80	8.30	2.90	3.80
2	10.00	10.80	3.60	6.30
3	9.50	11.10	4.00	7.00
4	9.50	11.00	5.80	9.70
5	8.80	10.80	5.40	8.80
MEAN	8.92	10.4	4.34	7.88

Tensile Strength of the fabric is very important while constructing a functional product. The strength of Neem treated fabric is not reduced when compared to the untreated fabric. So the strength is maintained even after treating the fabric. The Tensile Strength of the micro encapsulated fabric is comparatively high to the pad – dried fabric

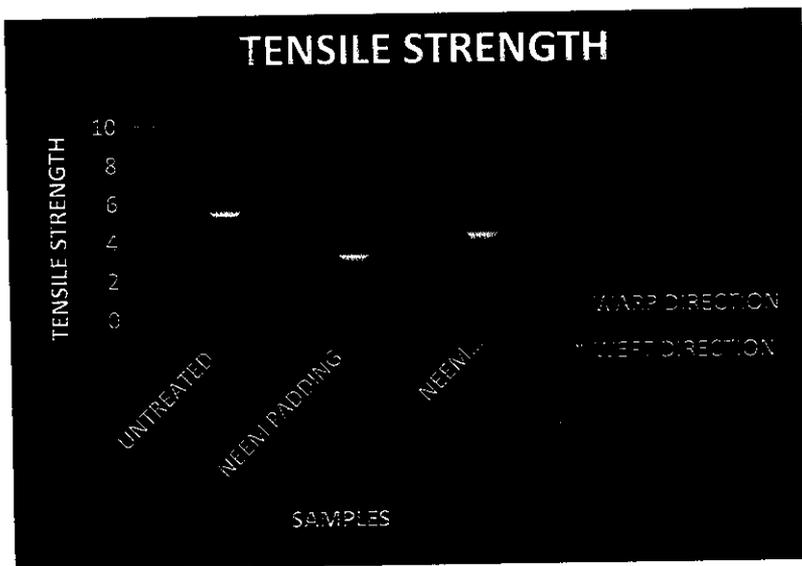


FIGURE – 5 FABRIC TENSILE STRENGTH - NEEM

And also the tensile strength in the warp direction is more than in weft direction.

4.5.1.2 MARIGOLD

TABLE - 15

FABRIC TENSILE STRENGTH - UNTREATED FABRIC

SL.NO	TENSILE STRENGTH	BREAKING FORCE	TENSILE STRENGTH	BREAKING FORCE
	WARP DIRECTION		WEFT DIRECTION	
1	6.10	7.40	5.00	8.80
2	9.30	11.60	6.20	11.10
3	8.30	9.90	5.20	10.10
4	10.20	12.10	5.70	10.80
5	9.40	11.50	5.80	10.10
MEAN	8.66	10.50	5.58	10.18

TABLE - 16

FABRIC TENSILE STRENGTH - MARIGOLD TREATED FABRIC (PADDING)

SL.NO	TENSILE STRENGTH	BREAKING FORCE	TENSILE STRENGTH	BREAKING FORCE
	WARP DIRECTION		WEFT DIRECTION	
1	8.80	11.90	3.30	6.20
2	5.10	5.40	2.00	1.60
3	7.30	9.00	2.30	2.26
4	6.40	8.50	2.20	1.60
5	7.80	9.10	4.40	9.80
MEAN	7.08	8.78	2.84	5.49

TABLE- 17

FABRIC TENSILE STRENGTH - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)

SL.NO	TENSILE STRENGTH	BREAKING FORCE	TENSILE STRENGTH	BREAKING FORCE
	WARP DIRECTION		WEFT DIRECTION	
1	8.40	13.90	3.60	7.10
2	8.30	13.90	4.10	9.10
3	10.00	17.70	3.60	7.00
4	6.80	9.70	4.50	9.15
5	8.20	12.80	5.50	10.23
MEAN	8.34	13.60	4.26	8.51

Tensile Strength of the fabric is very important while constructing a functional product. The strength of Marigold treated fabric is not reduced when compared to the untreated fabric. So the strength is maintained even after treating the fabric. The Tensile Strength of the micro encapsulated fabric is comparatively high to the pad – dried fabric. And also the tensile strength in the warp direction is more than in weft direction

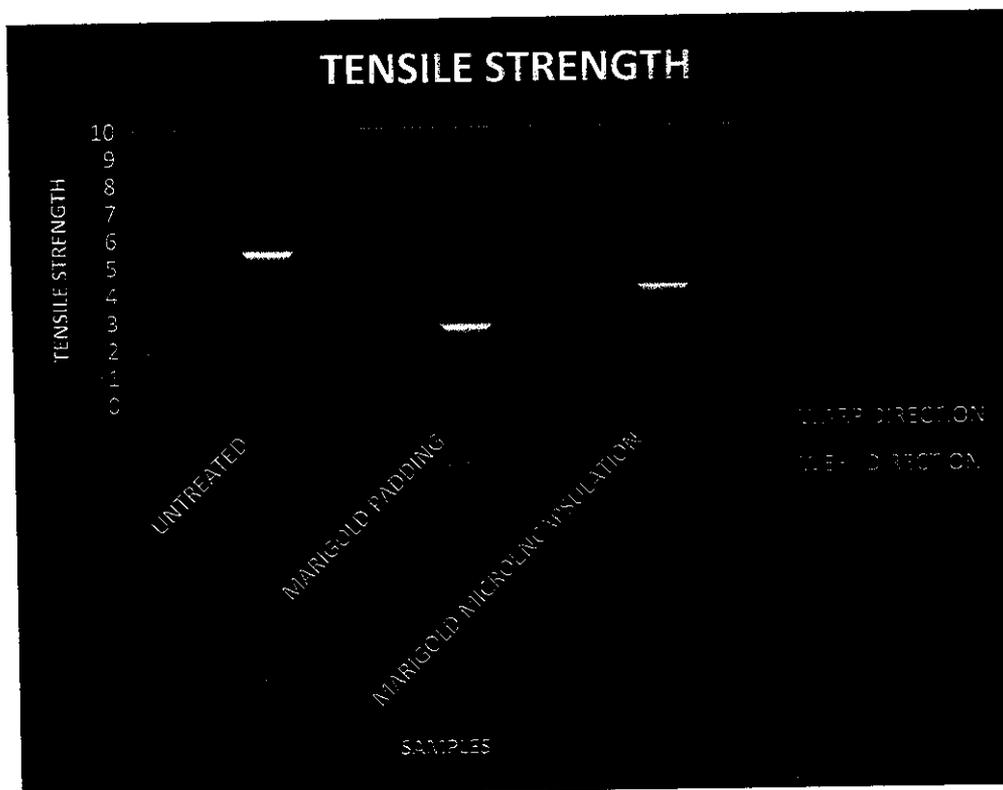


FIGURE - 6 - FABRIC TENSILE STRENGTH - MARIGOLD

4.5.2 ABRASION RESISTANCE

4.5.2.1 NEEM

TABLE -18

ABRASION RESISTANCE - UNTREATED FABRIC

SL.NO	INITIAL WEIGHT (gms)	FINAL WEIGHT (gms)	WEIGHT LOSS%	ABRASION RESISTANCE (%)
1	0.073	0.072	1.36	98.64
2	0.078	0.076	2.56	97.44
3	0.079	0.077	2.53	97.47
4	0.073	0.072	1.36	98.64
5	0.077	0.075	2.59	97.41
			MEAN	97.92

TABLE- 19**ABRASION RESISTANCE - NEEM TREATED FABRIC (PADDING)**

SL.NO	INITIAL WEIGHT (gms)	FINAL WEIGHT (gms)	WEIGHT LOSS%	ABRASION RESISTANCE (%)
1	0.076	0.074	2.63	97.37
2	0.079	0.076	3.79	96.21
3	0.077	0.075	2.59	97.41
4	0.078	0.077	1.28	98.72
5	0.076	0.075	1.31	98.69
			MEAN	97.68

TABLE - 20**ABRASION RESISTANCE - NEEM TREATED FABRIC (MICRO ENCAPSULATION)**

SL.NO	INITIAL WEIGHT (gms)	FINAL WEIGHT (gms)	WEIGHT LOSS%	ABRASION RESISTANCE (%)
1	0.083	0.080	3.61	96.39
2	0.086	0.085	1.16	98.84
3	0.084	0.083	1.19	98.81
4	0.085	0.083	2.35	97.65
5	0.084	0.082	2.38	97.72
			MEAN	97.88

The abrasion resistance has not reduced even after the finish has been given to the fabric. The abrasion resistance of the Neem treated fabric is of the same range of the untreated fabric. And the abrasion resistance in micro encapsulation treated fabric is more than in pad-dry treated fabric.

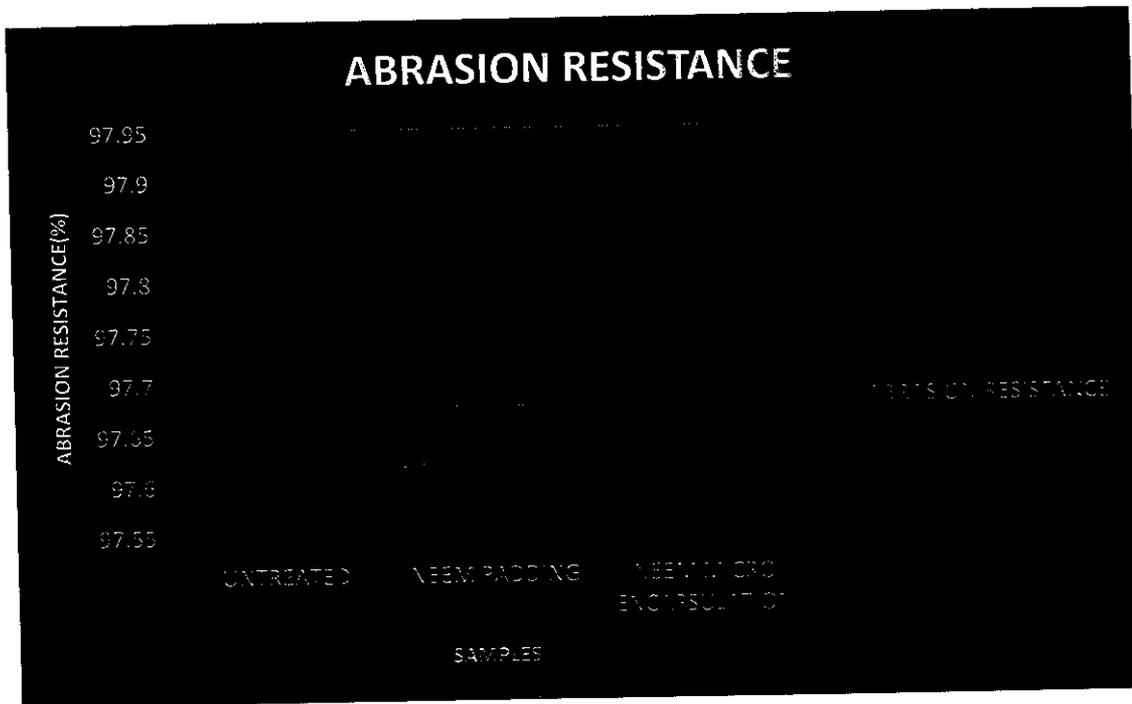


FIGURE- 7 - ABRASION RESISTANCE - NEEM

4.5.2.2 MARIGOLD

TABLE – 21

ABRASION RESISTANCE - UNTREATED FABRIC

SL.NO	INITIAL WEIGHT (gms)	FINAL WEIGHT (gms)	WEIGHT LOSS%	ABRASION RESISTANCE (%)
1	0.073	0.072	1.36	98.64
2	0.078	0.076	2.56	97.44
3	0.079	0.077	2.53	97.47
4	0.073	0.072	1.36	98.64
5	0.077	0.075	2.59	97.41
			MEAN	97.92

TABLE 22**ABRASION RESISTANCE - MARIGOLD TREATED FABRIC (PADDING)**

SL.NO	INITIAL WEIGHT (gms)	FINAL WEIGHT (gms)	WEIGHT LOSS%	ABRASION RESISTANCE (%)
1	0.082	0.080	2.43	97.57
2	0.076	0.074	2.63	97.37
3	0.081	0.080	1.23	98.77
4	0.078	0.076	2.56	97.44
5	0.079	0.078	1.26	98.74
			MEAN	97.97

TABLE - 23**ABRASION RESISTANCE -MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)**

SL.NO	INITIAL WEIGHT (gms)	FINAL WEIGHT (gms)	WEIGHT LOSS%	ABRASION RESISTANCE (%)
1	0.080	0.078	2.50	97.50
2	0.078	0.076	2.56	97.44
3	0.077	0.076	1.29	98.71
4	0.080	0.078	2.50	97.50
5	0.076	0.075	1.31	98.69
			MEAN	97.96

The abrasion resistance has not reduced even after the finish has been given to the fabric. The abrasion resistance of the Marigold treated fabric is of the same range of the untreated fabric. The abrasion resistance in micro encapsulation treated fabric and pad-dry treated fabric is of the same range.

ABRASION RESISTANCE

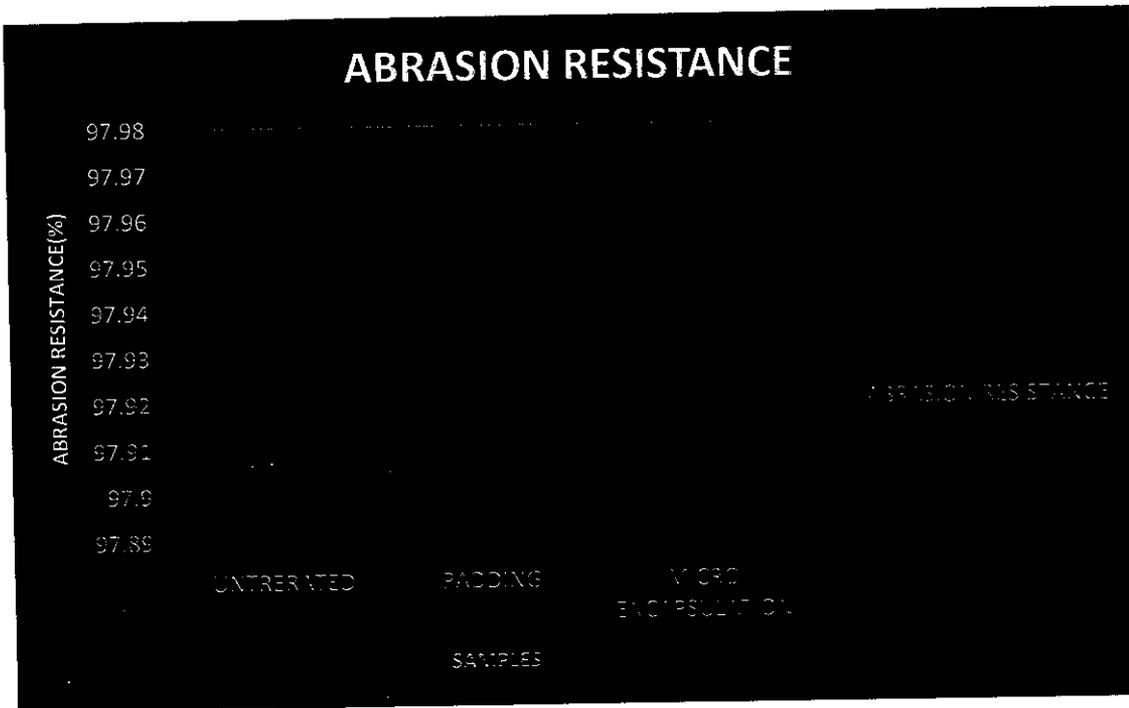


FIGURE- 8 - ABRASION RESISTANCE - MARIGOLD

4.5.3 FABRIC STIFFNESS

4.5.3.1 NEEM

TABLE - 24

FABRIC STIFFNESS - UNTREATED FABRIC

SL.NO	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm
	WARP DIRECTION		WEFT DIRECTION	
1	3.4	0.746	3.0	0.513
2	3.5	0.814	3.2	0.622
3	3.6	0.886	3.3	0.682
4	3.5	0.814	3.1	0.566
5	3.4	0.746	3.2	0.622
MEAN	3.4	0.8012	3.1	0.601

TABLE - 25

FABRIC STIFFNESS - NEEM TREATED FABRIC (PADDING)

SL.NO	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm
	WARP DIRECTION		WEFT DIRECTION	
1	2.9	0.487	2.7	0.391
2	2.8	0.439	2.6	0.351
3	2.5	0.312	2.3	0.243
4	2.8	0.439	2.5	0.312
5	2.9	0.487	2.9	0.487
MEAN	2.7	0.432	2.6	0.356

TABLE - 26

FABRIC STIFFNESS - NEEM TREATED FABRIC (MICRO ENCAPSULATION)

SL.NO	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm
	WARP DIRECTION		WEFT DIRECTION	
1	3.4	0.786	2.5	0.3125
2	3.2	0.655	2.4	0.2760
3	3.0	0.540	2.5	0.3125
4	3.2	0.655	2.4	0.2760
5	3.1	0.595	2.5	0.3125
MEAN	3.1	0.646	2.4	0.2975

The stiffness of the fabric is measured by knowing the bending modulus of the fabric. The stiffness of the Neem treated fabric has been reduced when compared to the stiffness of the untreated fabric. So, here we can infer that the comfort level has been increased due to the reduction in stiffness. Stiffness has been increased in micro encapsulated fabric since there is wall material in it, when compared with pad – dried fabric. Also warp stiffness is more when compared with weft stiffness.

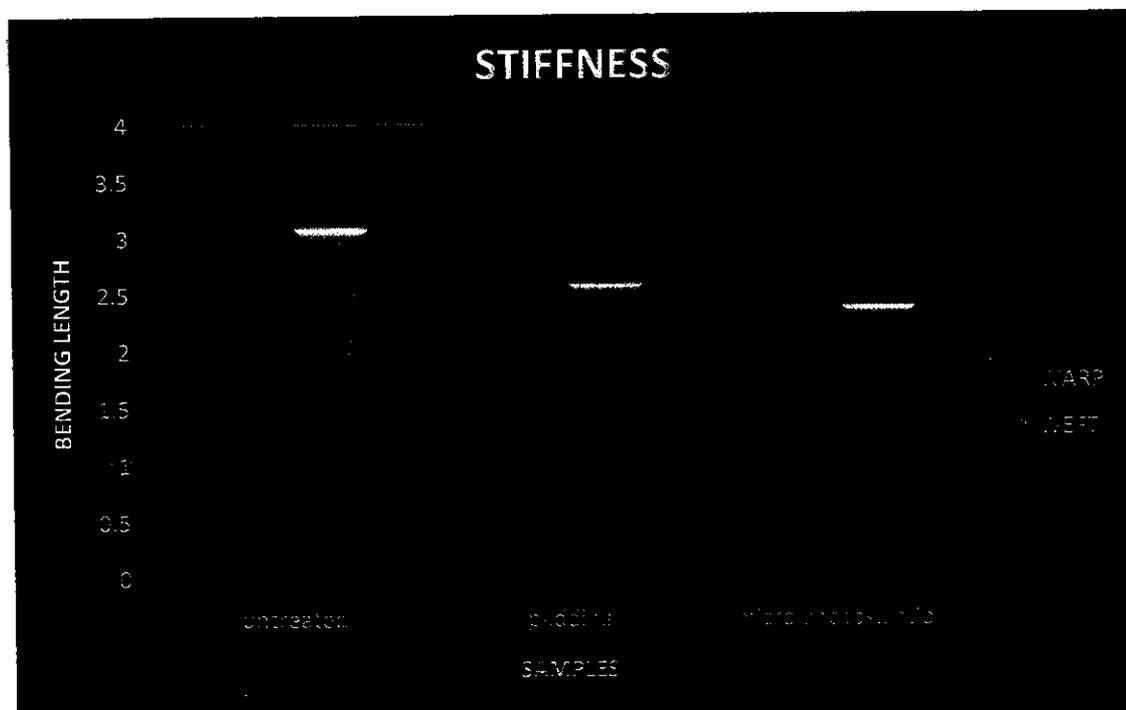


FIGURE – 9 - FABRIC STIFFNESS -NEEM

4.5.3.2 MARIGOLD- FABRIC STIFFNESS

TABLE - 27

FABRIC STIFFNESS - UNTREATED FABRIC

SL.NO	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm
	WARP DIRECTION		WEFT DIRECTION	
1	3.4	0.746	3.0	0.513
2	3.5	0.814	3.2	0.622
3	3.6	0.886	3.3	0.682
4	3.5	0.814	3.1	0.566
5	3.4	0.746	3.2	0.622
MEAN	3.4	0.8012	3.1	0.601

TABLE - 28

FABRIC STIFFNESS - MARIGOLD TREATED FABRIC (PADDING)

SL.NO	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm
	WARP DIRECTION		WEFT DIRECTION	
1	2.8	0.439	3.0	0.540
2	2.7	0.393	2.8	0.439
3	2.5	0.312	2.6	0.351
4	2.6	0.351	2.7	0.393
5	2.7	0.393	2.8	0.439
MEAN	2.6	0.377	2.7	0.432

TABLE - 29

FABRIC STIFFNESS - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)

SL.NO	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm	BENDING LENGTH(C) in cm	FLEXURAL RIGIDITY(G) in mg.cm
	WARP DIRECTION		WEFT DIRECTION	
1	3.4	0.857	2.4	0.276
2	3.6	0.933	2.9	0.487
3	3.8	1.097	2.8	0.439
4	4.0	1.280	2.5	0.312
5	3.5	0.8575	3.0	0.540
MEAN	3.6	1.004	2.7	0.410

The stiffness of the fabric is measured by knowing the bending modulus of the fabric. The stiffness of the Marigold treated fabric has been reduced when compared to the stiffness of the untreated fabric. So, here we can infer that the comfort level has been increased due to the reduction in stiffness.

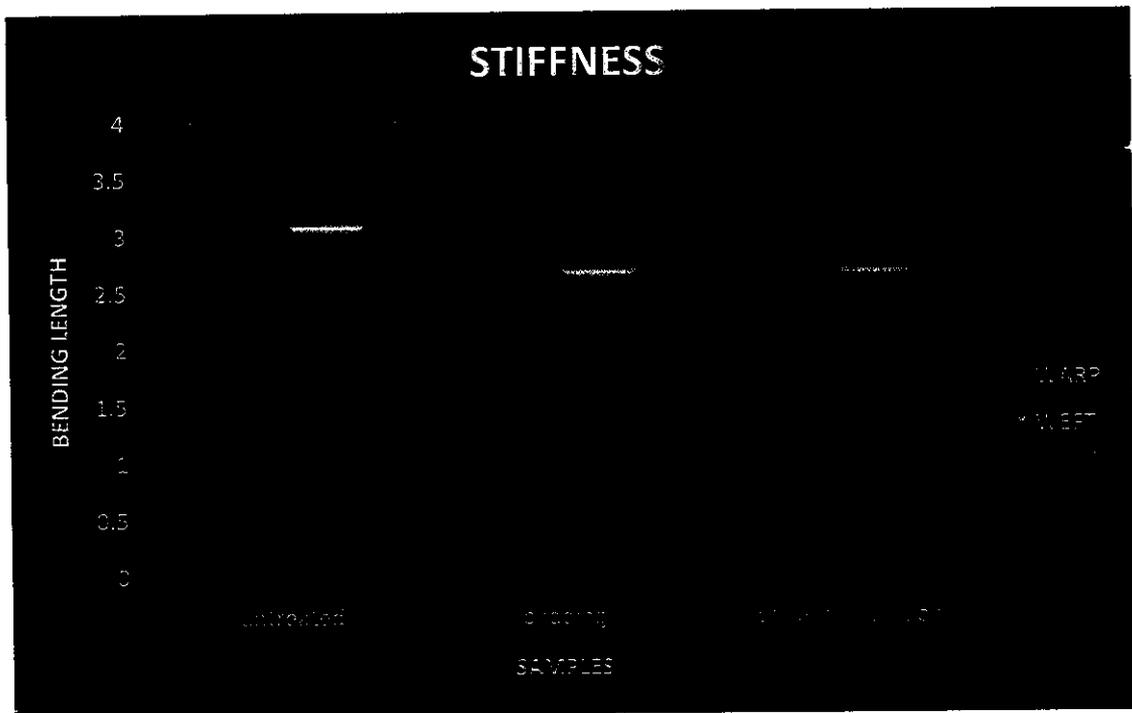


FIGURE – 10 - FABRIC STIFFNESS -MARIGOLD

4.5.4 FABRIC THICKNESS

4.5.4.1 NEEM

TABLE - 30

FABRIC THICKNESS - UNTREATED FABRIC

SL.NO	THICKNESS IN mm
1	0.021
2	0.020
3	0.021
4	0.020
5	0.022
MEAN	0.020

TABLE - 31

FABRIC THICKNESS - NEEM TREATED FABRIC (PADDING)

SL.NO	THICKNESS IN mm
1	0.020
2	0.022
3	0.021
4	0.022
5	0.021
MEAN	0.021

TABLE - 32

FABRIC THICKNESS - NEEM TREATED FABRIC (MICRO ENCAPSULATION)

SL.NO	THICKNESS IN mm
1	0.021
2	0.020
3	0.020
4	0.020
5	0.019
MEAN	0.020

The fabric thickness in the Neem treated fabric has been found in same range as in the untreated fabric. So the fabric bulkiness has not been increased even after the finish has been given to the fabric.

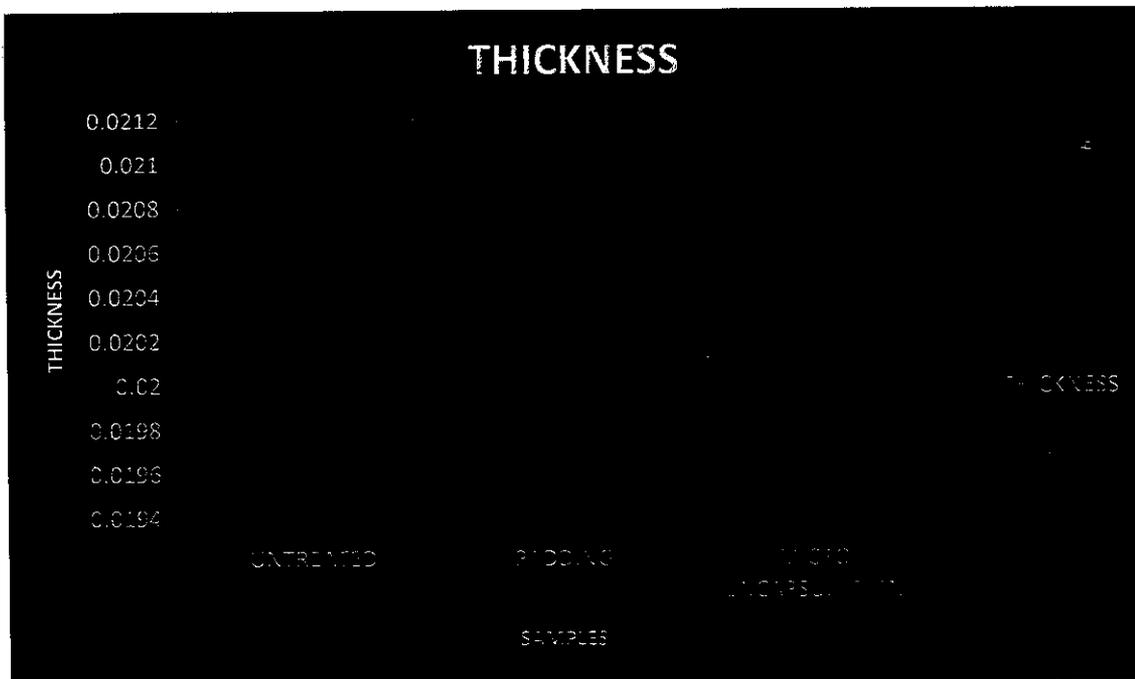


FIGURE – 11 - FABRIC THICKNESS - NEEM

4.5.4.2 MARIGOLD

TABLE - 33

FABRIC THICKNESS - UNTREATED FABRIC

SL.NO	THICKNESS IN mm
1	0.021
2	0.020
3	0.021
4	0.020
5	0.022
MEAN	0.020

TABLE - 34

FABRIC THICKNESS - MARIGOLD TREATED FABRIC (PADDING)

SL.NO	THICKNESS IN mm
1	0.021
2	0.022
3	0.022

4	0.021
5	0.022
MEAN	0.021

TABLE - 35

FABRIC THICKNESS - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)

SL.NO	THICKNESS IN mm
1	0.022
2	0.021
3	0.021
4	0.022
5	0.022
MEAN	0.021

The fabric thickness in the Marigold treated fabric has been found same as in the untreated fabric. So the fabric bulkiness has not been increased even after the finish has been given to the fabric.

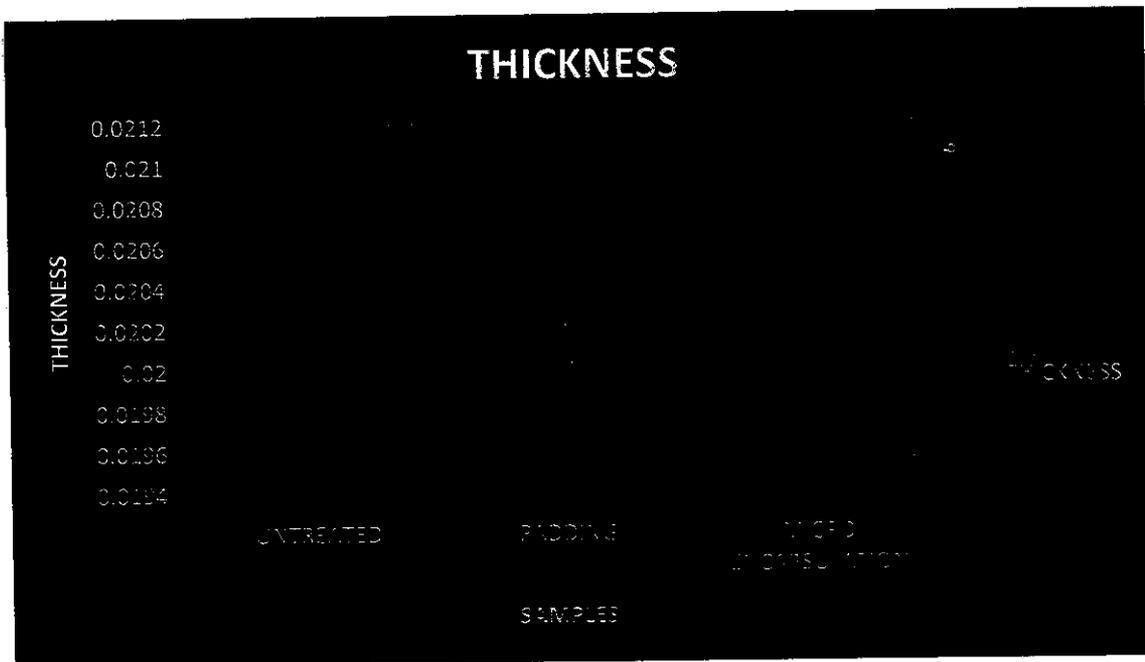


FIGURE – 12 - FABRIC THICKNESS - MARIGOLD

4.5.5 FABRIC DRAPE:

4.5.5.1 NEEM

TABLE - 36

FABRIC DRAPE - UNTREATED FABRIC

SL.NO	W _s (gms)	W _d (gms)	W _D (gms)	D (%)
1	2.823	1.865	3.675	52.90
2	2.850	1.865	3.675	54.40
3	2.832	1.865	3.675	53.40
4	2.845	1.865	3.675	54.14
5	2.825	1.865	3.675	53.00
			MEAN	53.56

TABLE - 37**FABRIC DRAPE - NEEM TREATED FABRIC (PADDING)**

SL.NO	W _s (gms)	W _d (gms)	W _D (gms)	D (%)
1	3.114	1.865	3.675	69
2	3.110	1.865	3.675	68.78
3	3.119	1.865	3.675	69.28
4	3.112	1.865	3.675	68.89
5	3.115	1.865	3.675	69.06
			MEAN	69

TABLE - 38**FABRIC DRAPE - NEEM TREATED FABRIC (MICRO ENCAPSULATION)**

SL.NO	W _s (gms)	W _d (gms)	W _D (gms)	D (%)
1	2.833	1.865	3.675	53.48
2	2.835	1.865	3.675	53.59
3	2.834	1.865	3.675	53.53
4	2.836	1.865	3.675	53.64
5	2.835	1.865	3.675	53.59
			MEAN	53.56

Drapability of the fabric is an important factor. So, when smaller the value of d, higher is the Drapability of the fabric. Here the Drapability of the Neem treated fabric is in the same range of the untreated fabric.

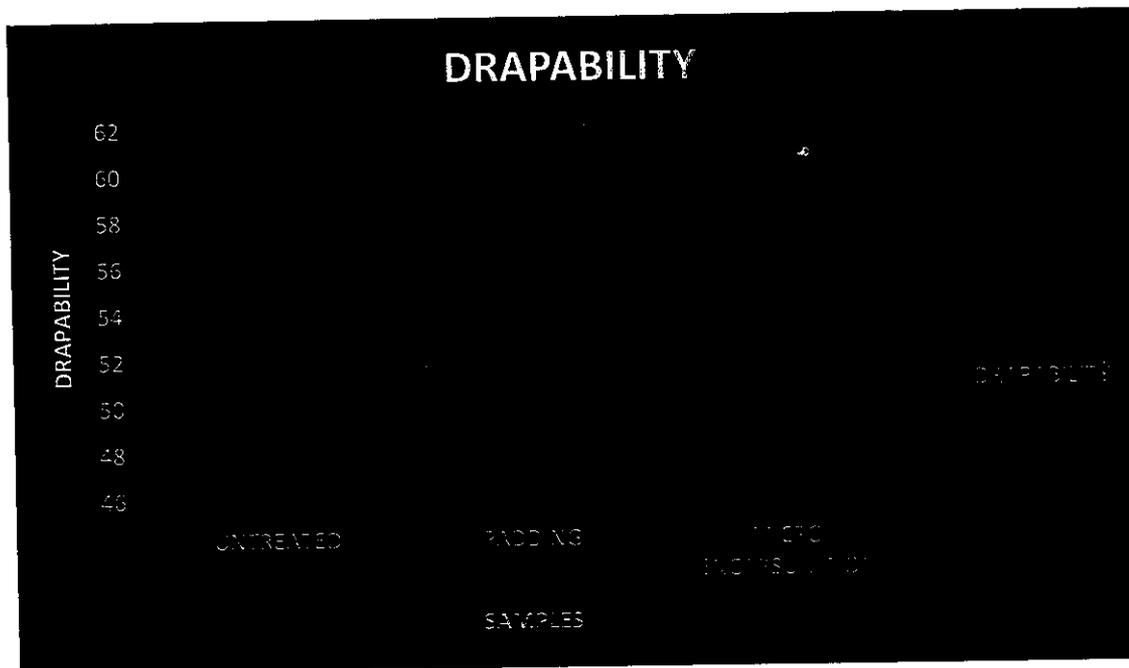


FIGURE – 31 - FABRIC DRAPE - NEEM

4.5.5.2 MARIGOLD

TABLE - 39

FABRIC DRAPE - UNTREATED FABRIC

SL.NO	W _s (gms)	W _d (gms)	W _D (gms)	D (%)
1	2.823	1.865	3.675	52.90
2	2.850	1.865	3.675	54.40
3	2.832	1.865	3.675	53.40
4	2.845	1.865	3.675	54.14
5	2.825	1.865	3.675	53.00
			MEAN	53.56

TABLE - 40

FABRIC DRAPE - MARIGOLD TREATED FABRIC (PADDING)

SL.NO	W _s (gms)	W _d (gms)	W _D (gms)	D (%)
1	2.795	1.865	3.675	51.38
2	2.793	1.865	3.675	51.27
3	2.780	1.865	3.675	50.55

4	2.786	1.865	3.675	50.88
5	2.789	1.865	3.675	51.04
			MEAN	51.02

TABLE - 41

FABRIC DRAPE - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)

SL.NO	W _s (gms)	W _d (gms)	W _D (gms)	D (%)
1	2.965	1.865	3.675	60.77
2	2.950	1.865	3.675	59.94
3	2.962	1.865	3.675	60.60
4	2.960	1.865	3.675	60.49
5	2.963	1.865	3.675	60.66
			MEAN	60.49

Drapability of the fabric is an important factor. So, when smaller the value of d, higher is the Drapability of the fabric. Here the Drapability of the Marigold treated fabric is in the same range of the untreated fabric.

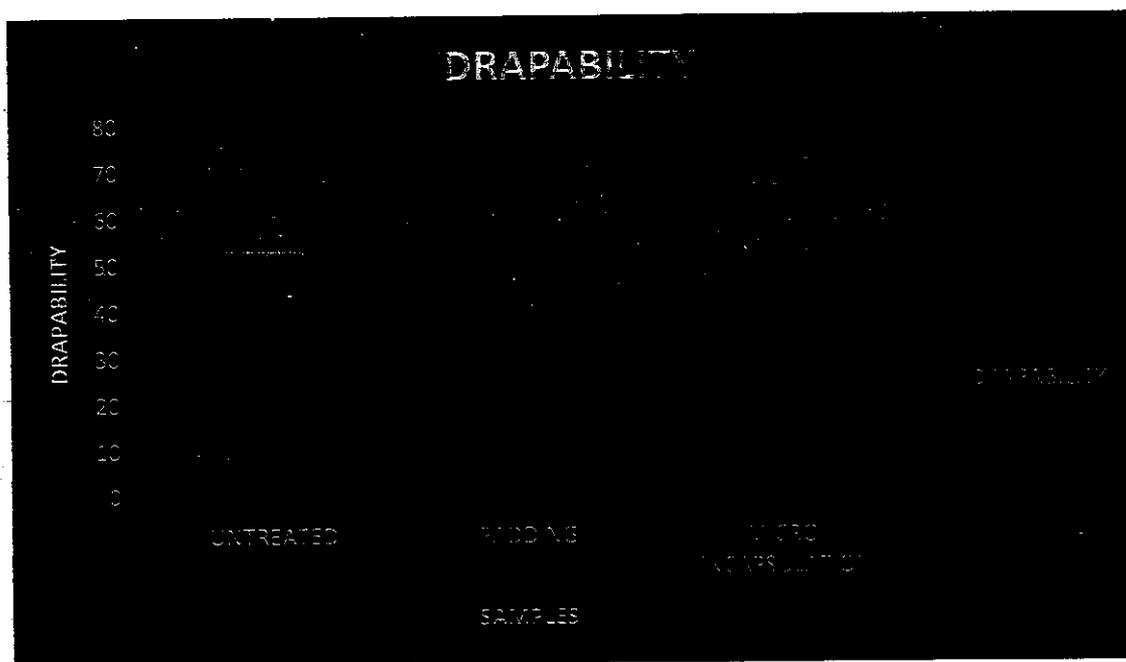


FIGURE - 14 - FABRIC DRAPE - MARIGOLD

4.5.6 WICKING TEST:

TABLE - 42

WICKING TEST

TIME IN min	HEIGHT IN cm		
	UN TREATED FABRIC (water)	UN TREATED FABRIC (Neem extract)	UN TREATED FABRIC (Marigold extract)
5	4	2	
10	5.5	2.1	1.5
15	5.7	2.5	2.2
20	5.7	2.5	2.5
25	5.8	2.5	2.5
30	6	2.7	2.5

The wick ability test is done for untreated fabric in three different solutions such as water, Neem extract, and marigold extract. The absorbency is more in water than in extracts.

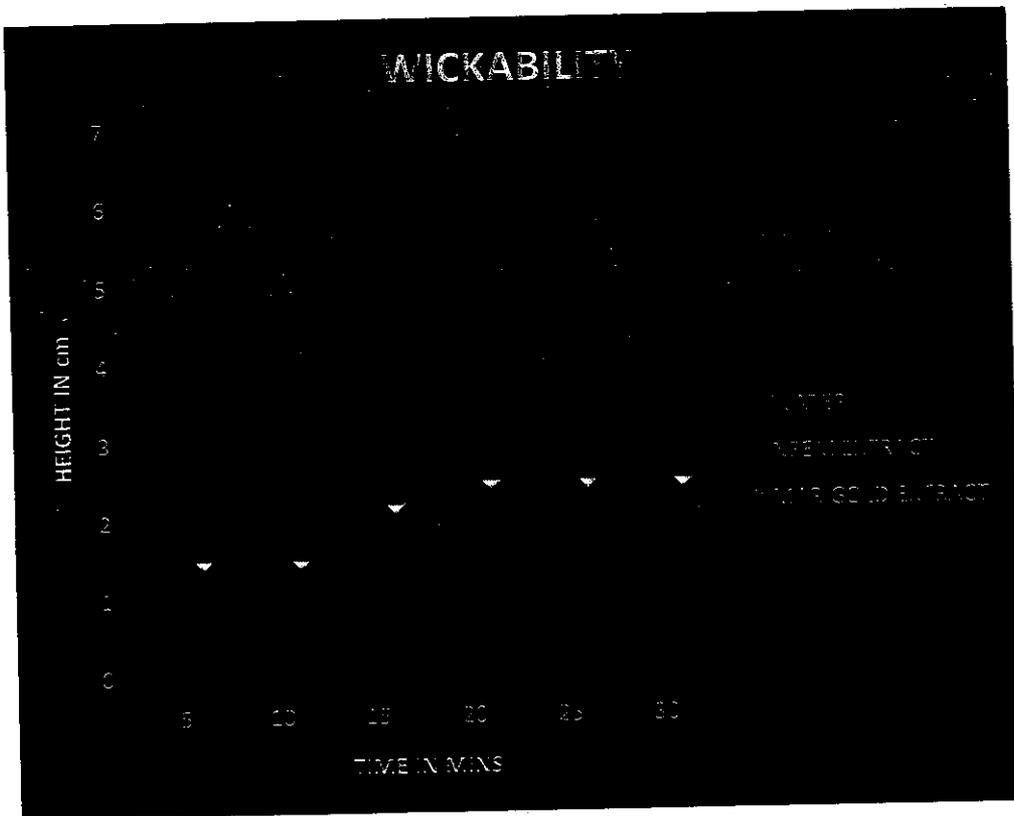


FIGURE – 15 –WICKING TEST

4.6 WASH DURABILITY TEST:

4.6.1 NEEM - AATCC 147 Qualitative - Agar diffusion test - Bacteria

TABLE - 43

WASH DURABILITY - NEEM TREATED FABRIC (PADDING)

SL.NO	NO. OF WASHES	ZONE OF INHIBITION (mm)	NO. OF WASHES	ZONE OF INHIBITION (mm)
	S.AUREUS		E.COLI	
1	1	25	1	25
2	3	25	3	25
3	5	24	5	24
4	10	22	10	23
5	15	21	15	21
6	20	20	20	20

TABLE - 44

WASH DURABILITY - NEEM TREATED FABRIC (MICRO ENCAPSULATION)

SL.NO	NO. OF WASHES	ZONE OF INHIBITION (mm)	NO. OF WASHES	ZONE OF INHIBITION (mm)
	S.AUREUS		E.COLI	
1	1	25	1	25
2	3	25	3	25
3	5	24	5	24
4	10	23	10	23
5	15	21	15	22
6	20	20	20	22

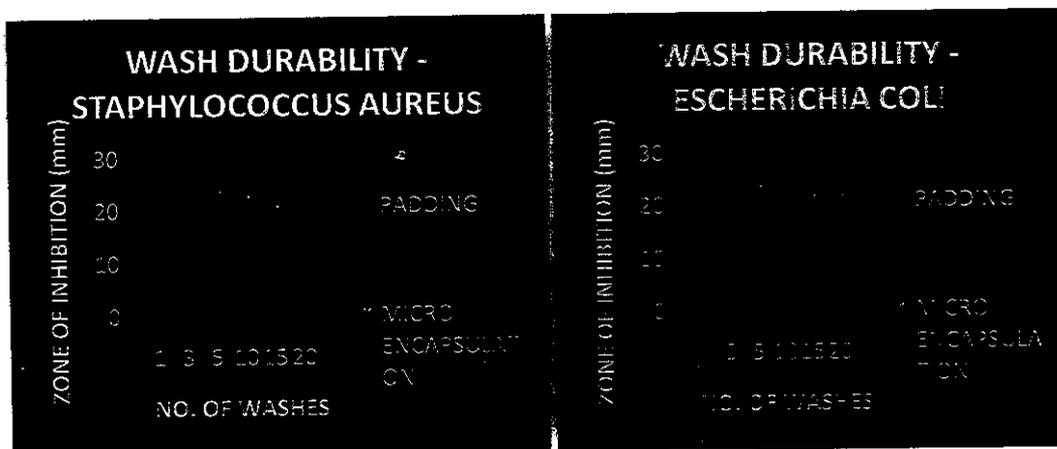


FIGURE - 16 – WASH DURABILITY NEEM

The Anti-Microbial property of Neem treated fabric is given in the above table. It is found that the treated fabric inhibits the growth of bacteria even after several washes. This shows that the fabric can be re-used for several times. The microencapsulated fabric has more wash durability than padded fabric

4.6.2 MARIGOLD - AATCC 147 Qualitative - Agar diffusion test - Bacteria

TABLE - 45

WASH DURABILITY - MARIGOLD TREATED FABRIC (PADDING)

SL.NO	NO. OF WASHES	ZONE OF INHIBITION (mm)	NO. OF WASHES	ZONE OF INHIBITION (mm)
	S.AUREUS		E.COLI	
1	1	25	1	26
2	3	24	3	25
3	5	24	5	25
4	10	23	10	23
5	15	21	15	22
6	20	20	20	20

TABLE - 46

WASH DURABILITY - MARIGOLD TREATED FABRIC (MICRO ENCAPSULATION)

SL.NO	NO. OF WASHES	ZONE OF INHIBITION (mm)	NO. OF WASHES	ZONE OF INHIBITION (mm)
	S.AUREUS		E.COLI	
1	1	27	1	28
2	3	26	3	26
3	5	26	5	26
4	10	25	10	24
5	15	23	15	24
6	20	22	20	23

The Anti-Microbial property of Marigold treated fabric is given in the above table. It is found that the treated fabric inhibits the growth of bacteria even after several washes. This shows that the fabric can be re-used for several times. The microencapsulated fabric has more wash durability than padded fabric.

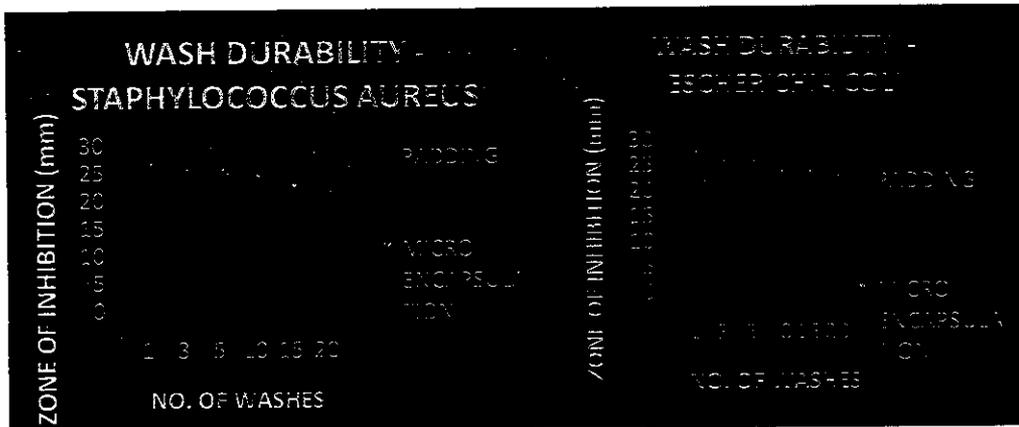


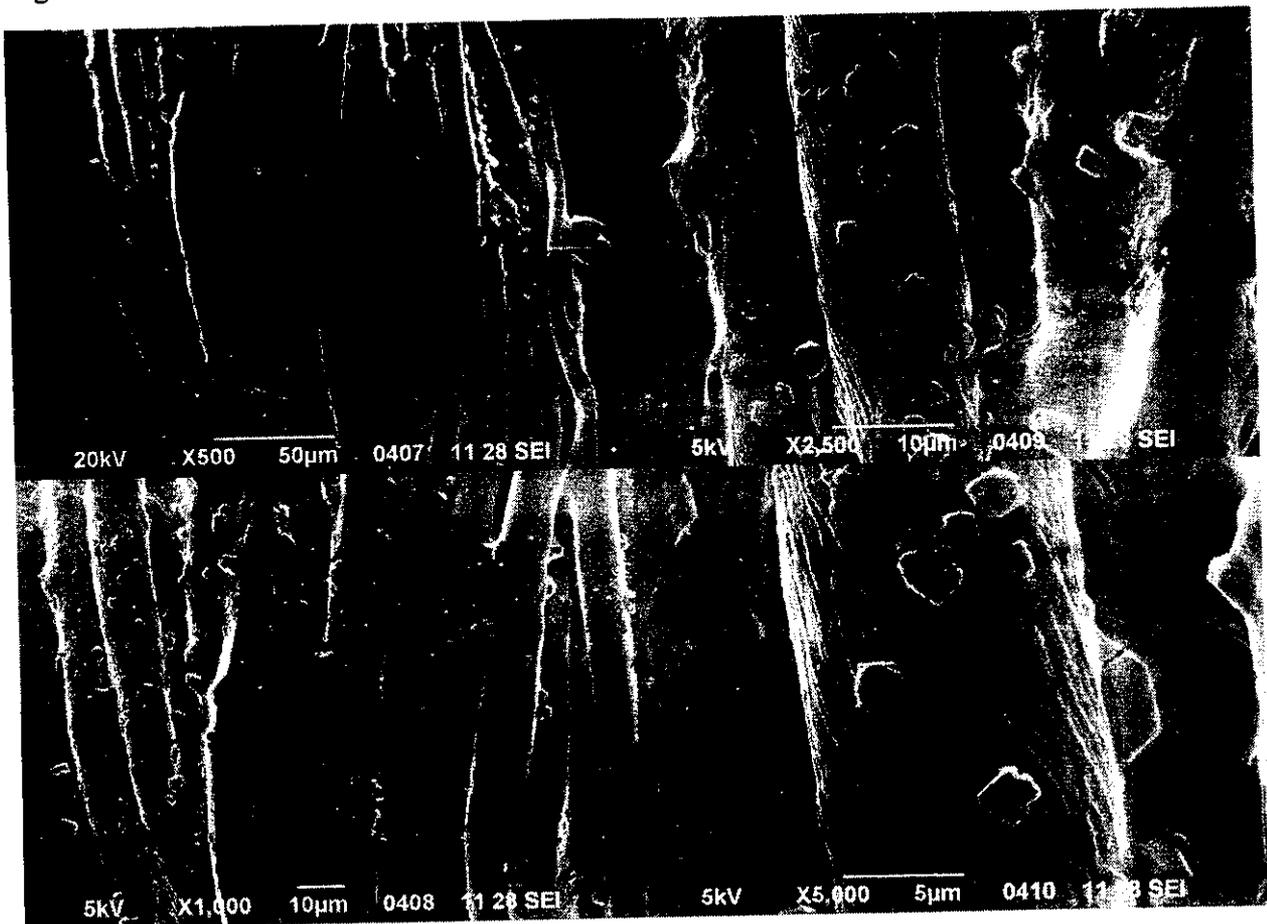
FIGURE - 17 - WASH DURABILITY - MARIGOLD

4.7 SEM STUDY

4.7.1 NEEM

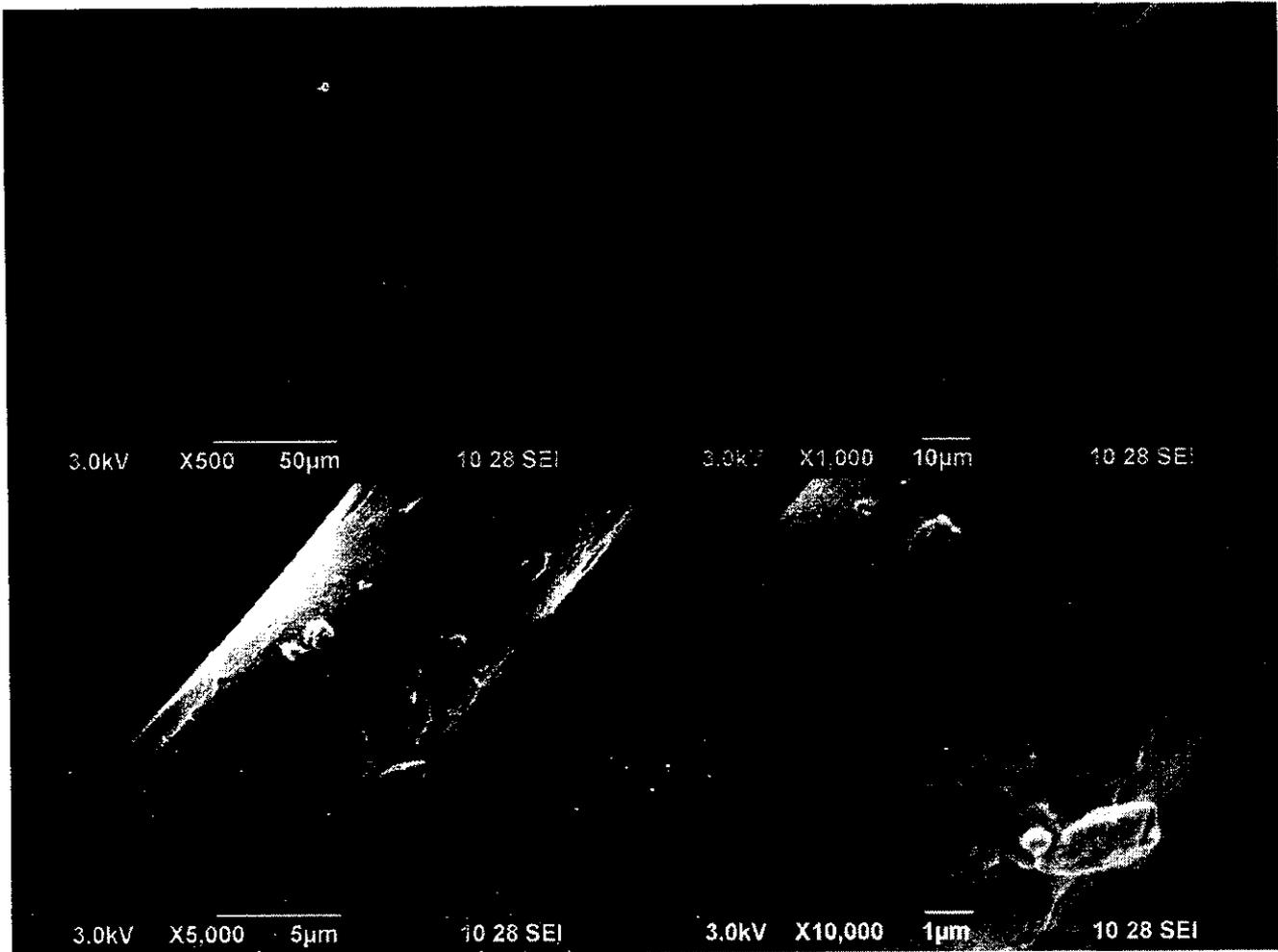
TEST METHOD

The morphology of microcapsule-treated fabric was analyzed using high-resolution scanning electron microscope with suitable accelerating voltage and magnifications. The scanning electron microscopy was used for confirming the binding of microcapsules and alignment onto the fabric samples.



The presence, binding and availability of microcapsules on the fabric were analyzed using scanning electron microscopy. The SEM photographs are shown in figure at different magnification levels as x500, x1000, x2500, x5000. It's clear that the microcapsules are present in the interstices of the fiber assembly of fabric. And the capsule formation is seen perfectly in x5000 magnification.

4.7.2 MARIGOLD

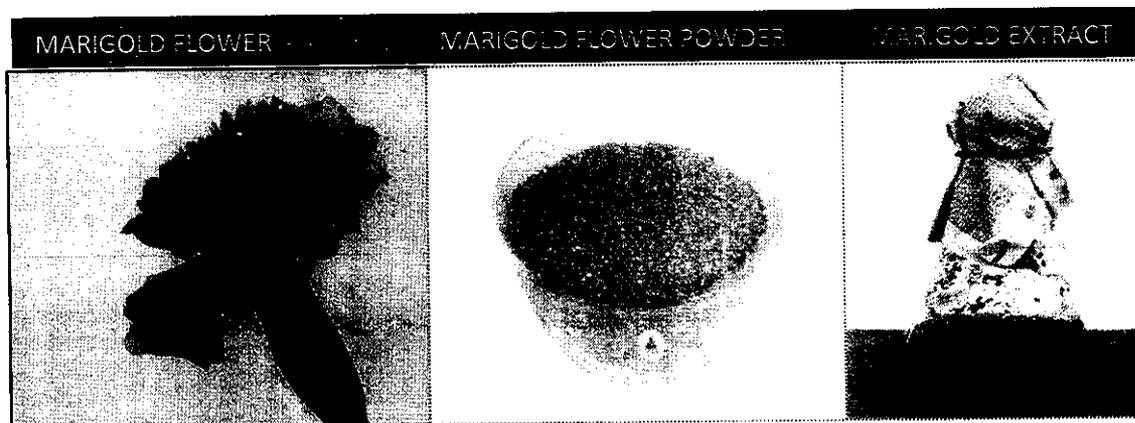
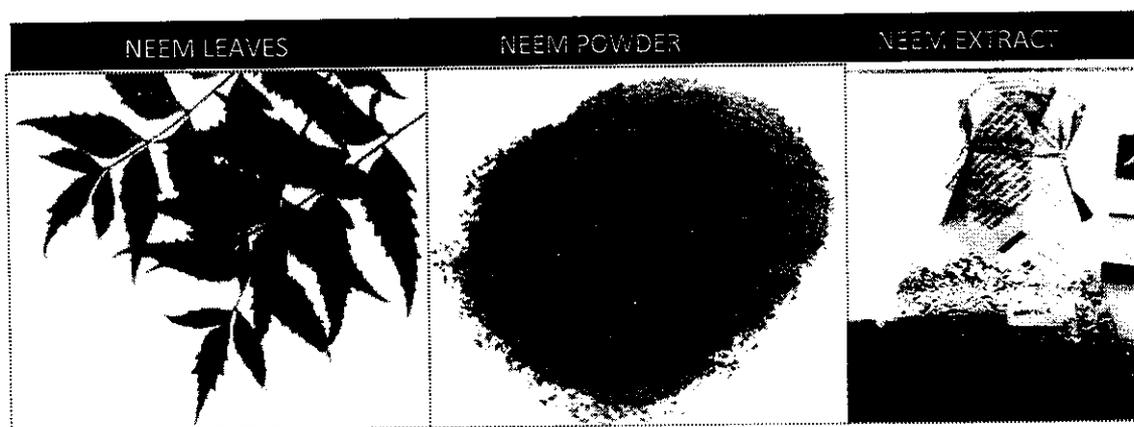


The presence, binding and availability of microcapsules on the fabric were analyzed using scanning electron microscopy. The SEM photographs are shown in figure at different magnification levels as x500, x1000, x2500, x5000. It's clear that the microcapsules are present in the interstices of the fiber assembly of fabric. And the capsule formation is seen perfectly in x5000 magnification.

PLATES

LIST OF PLATES

PLATE-1



OPTIMISATION OF SOLVENTS

PLATE 2 - NEEM

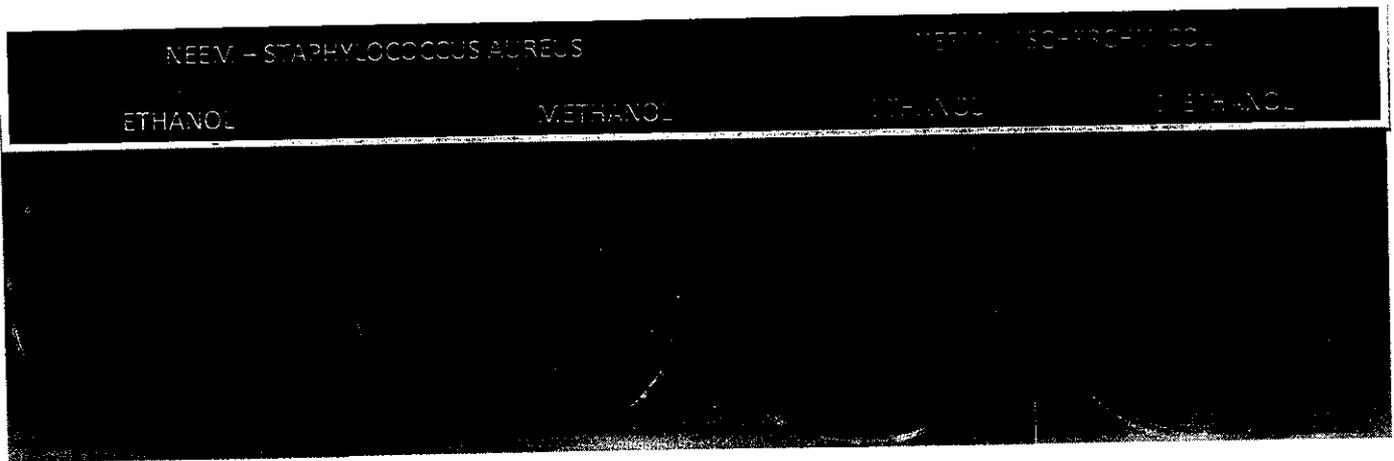


PLATE 3 - MARIGOLD

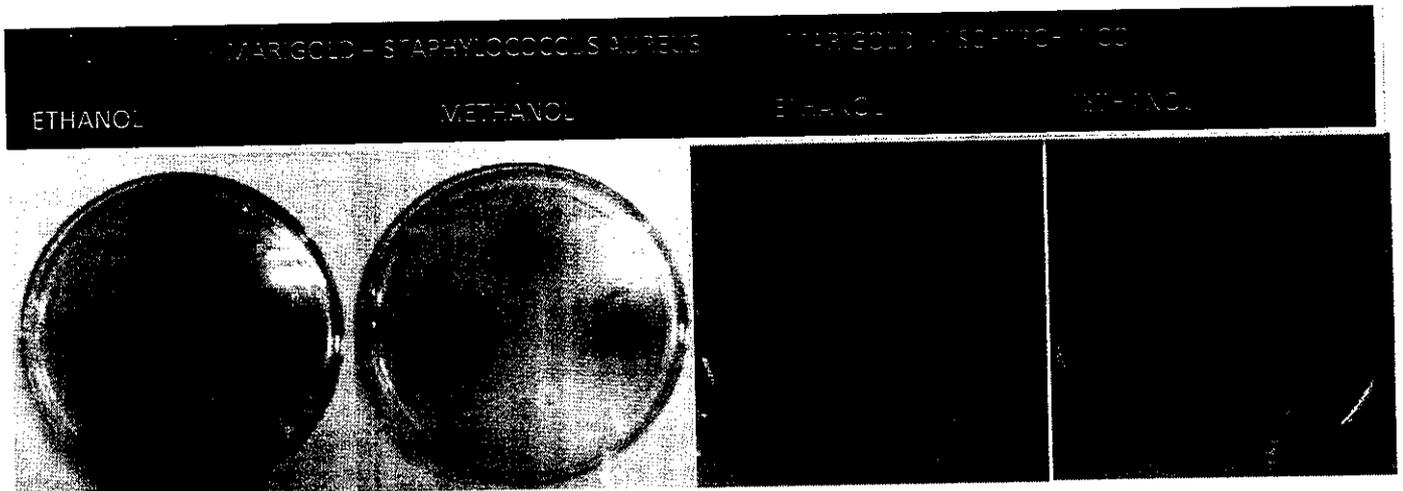


PLATE 4

NEEM - ANTI-BACTERIAL ACIVITY

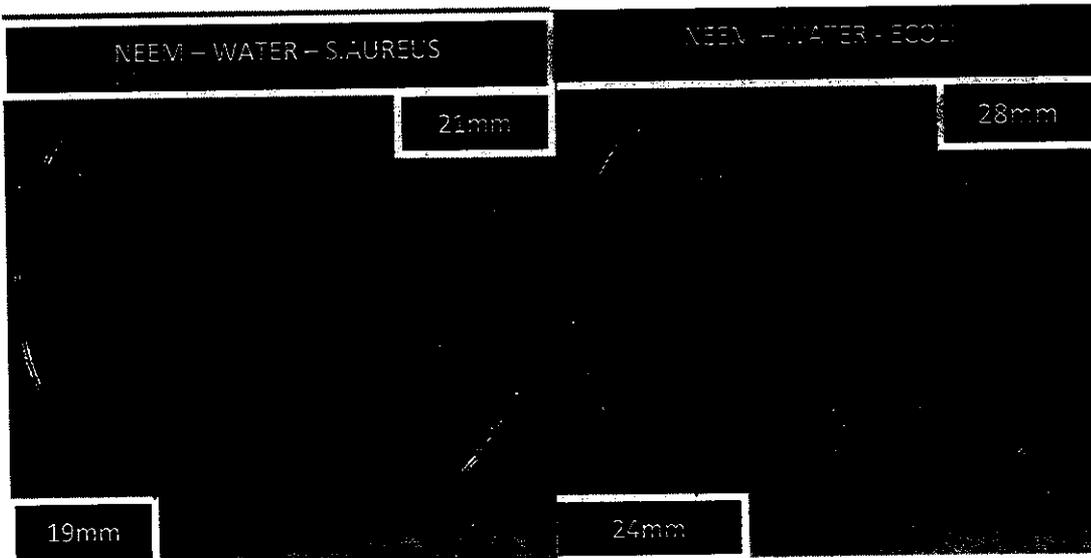


PLATE 5

MARIGOLD - ANTI-BACTERIAL ACIVITY

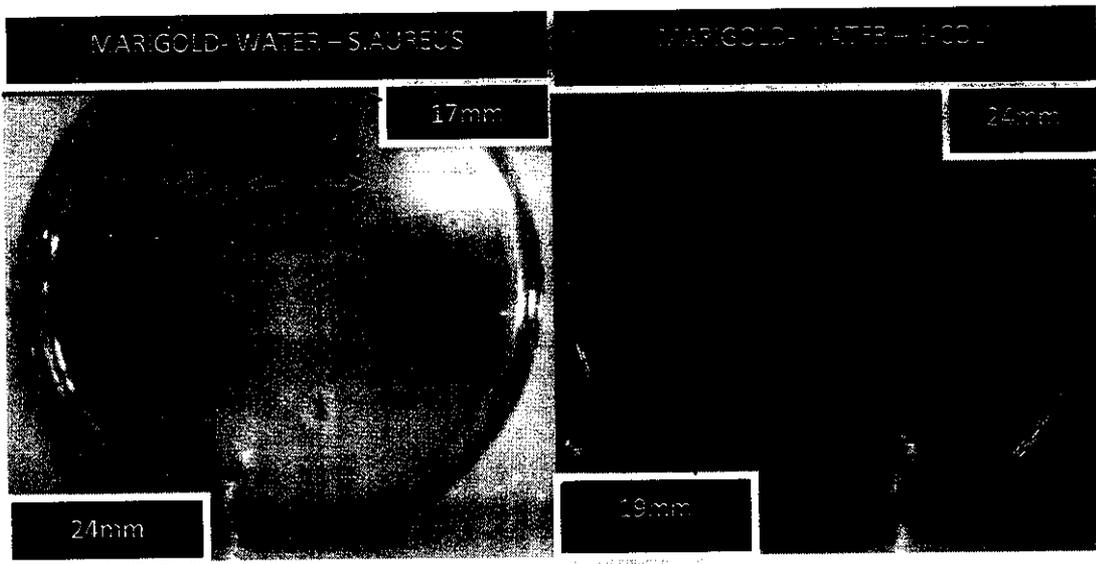


PLATE - 6

OPTIMISATION OF PROCESS CONDITIONS -BEST ZONE

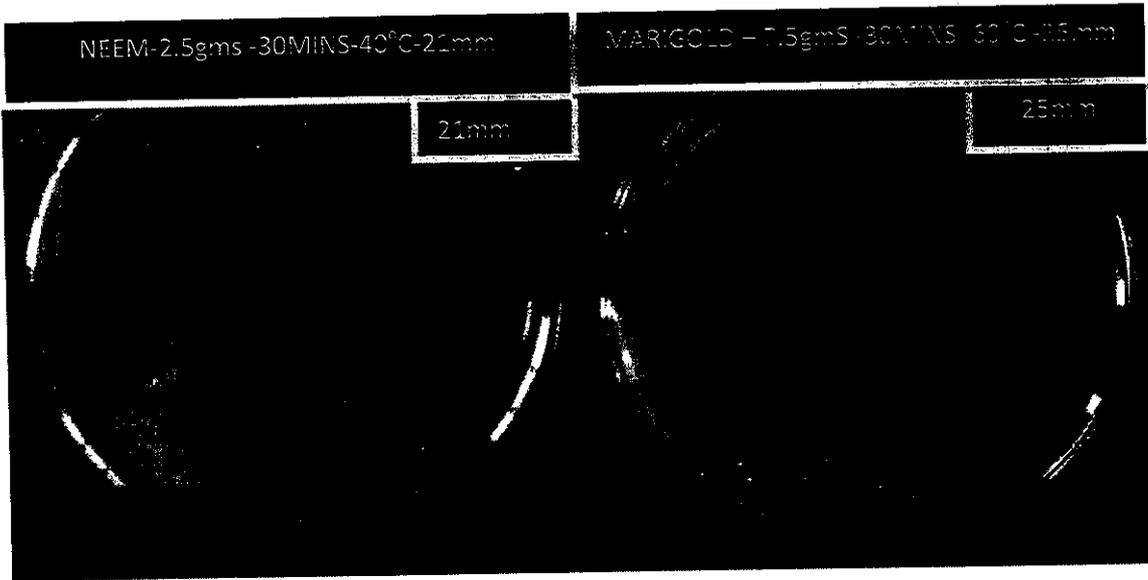


PLATE - 7

ANTI FUNGAL ACTIVITY (AATCC 30)

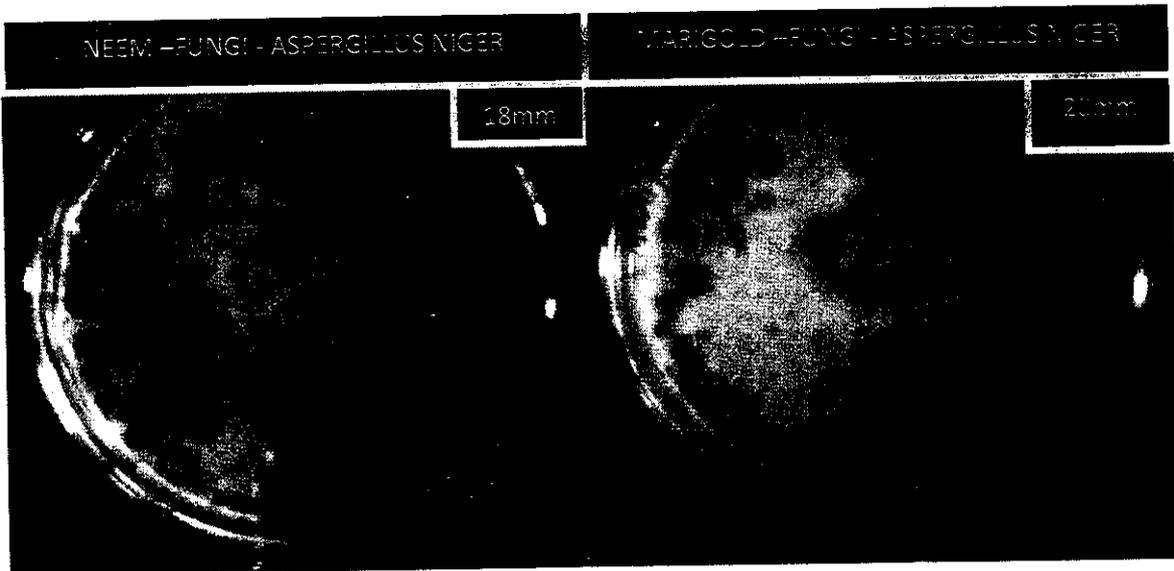
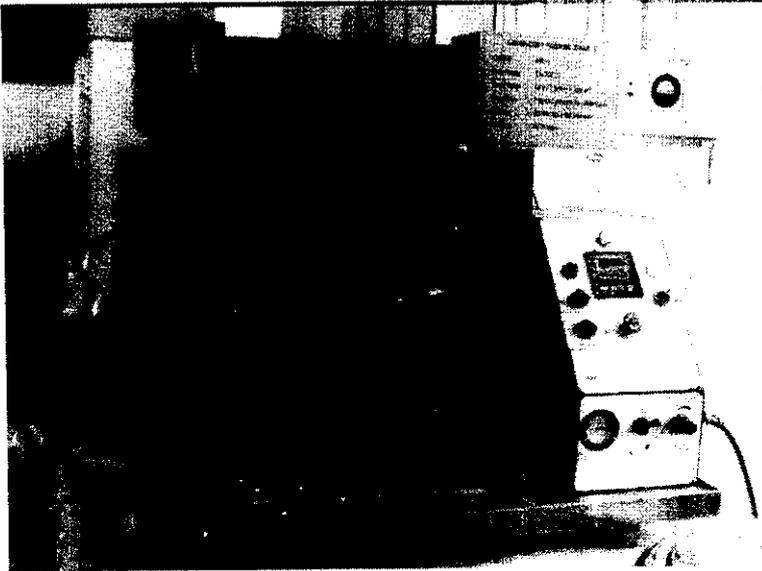


PLATE - 8

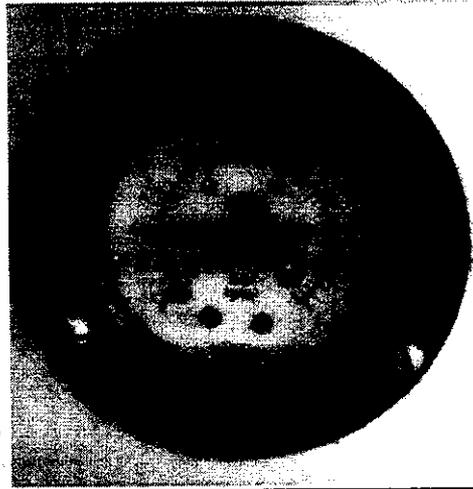
MACHINES USED FOR APPLYING FINISH TO THE FABRIC

PADDING MANGLES

PADDING MANGLE



PRESSURE DIAL



INTAKE OF FABRIC IN PADDING MANGLE

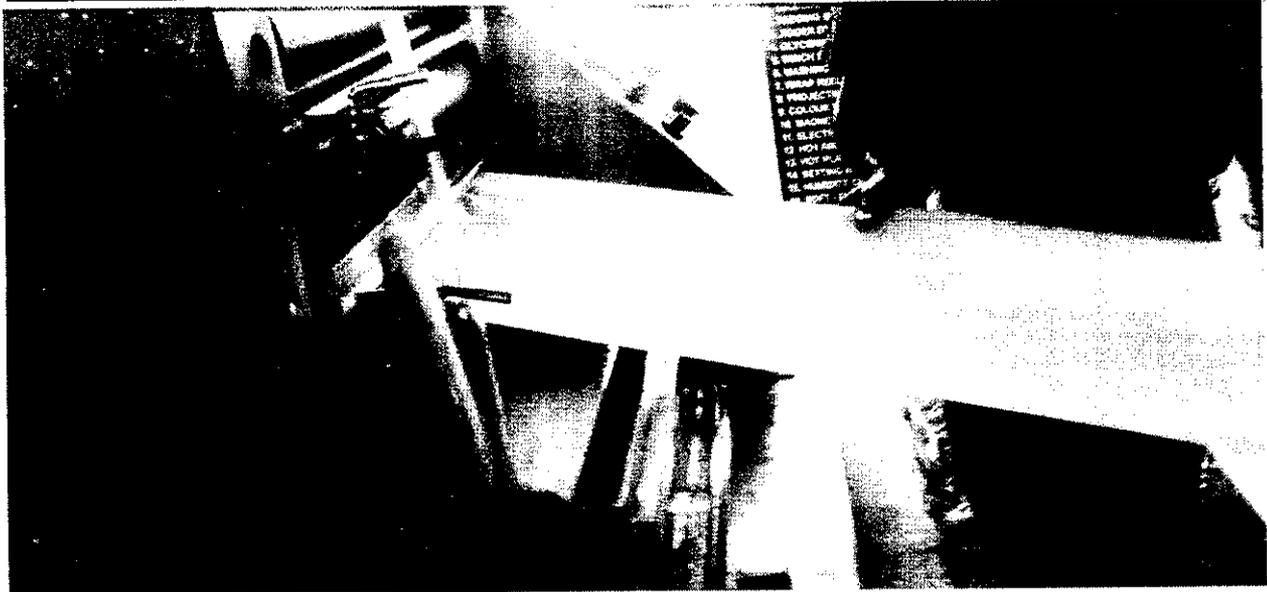
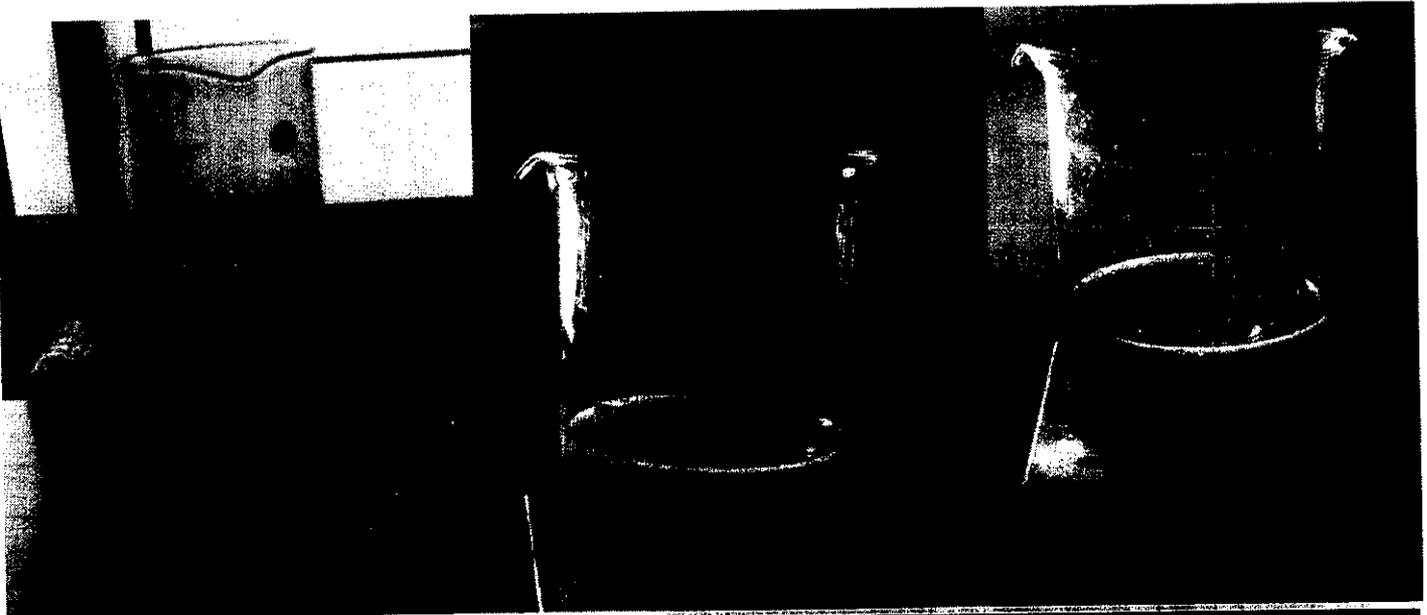


PLATE - 9

MICRO ENCAPSULATION METHOD



Wall material with water

Allowed to settle

250 ml. Hot water for 15 mins



500ml of Core material for 15 mins

20% of Sodium Sulphate for 5-10 mins

125 ml of 10% formalin

CONSTRUCTED PRODUCTS
PLATE - 10 - NEEM PRODUCT

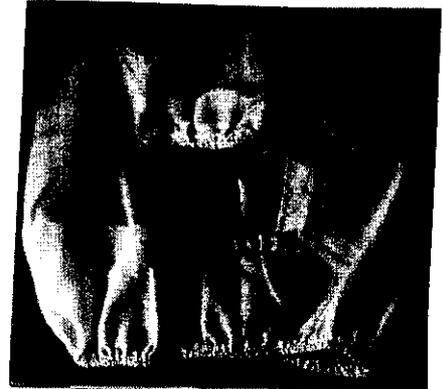


PLATE - 11 - MARIGOLD PRODUCT



WEAR STUDY
PLATE - 12 NEEM PRODUCT



PLATE - 13 MARIGOLD PRODUCT



WASH DURABILITY
PLATE - 14 - NEEM - S.AUREUS

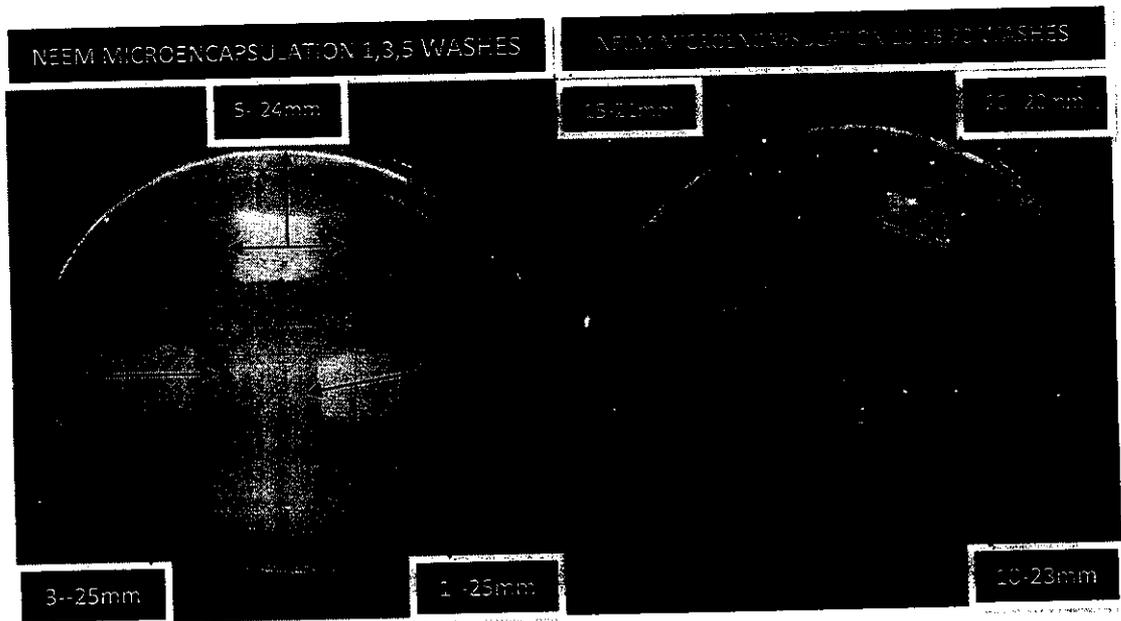
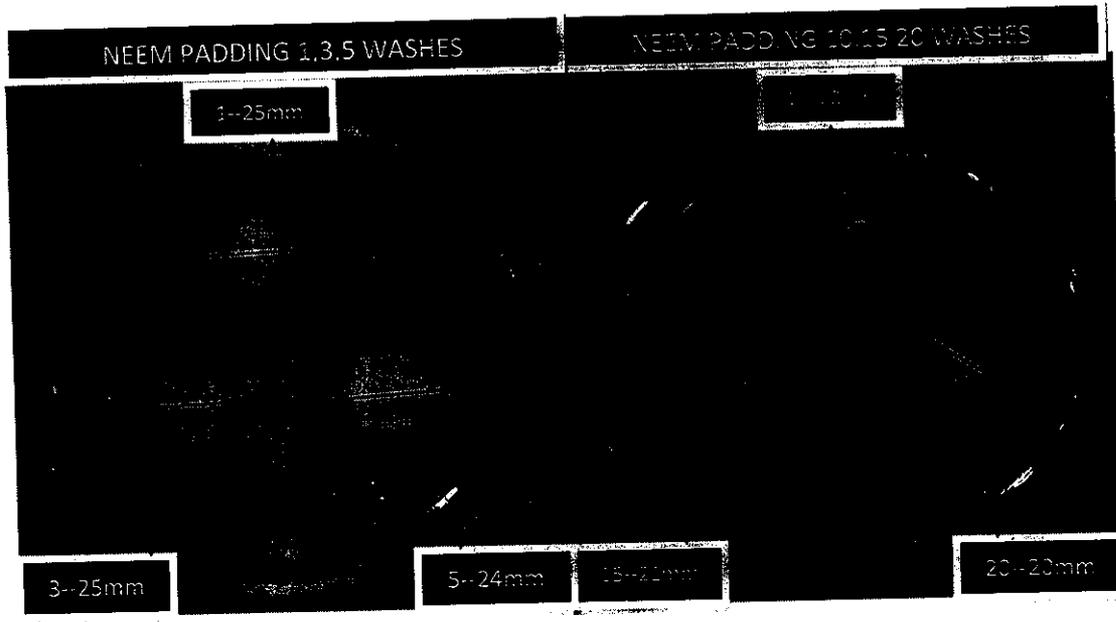


PLATE 15 – MARIGOLD – S. AUREUS

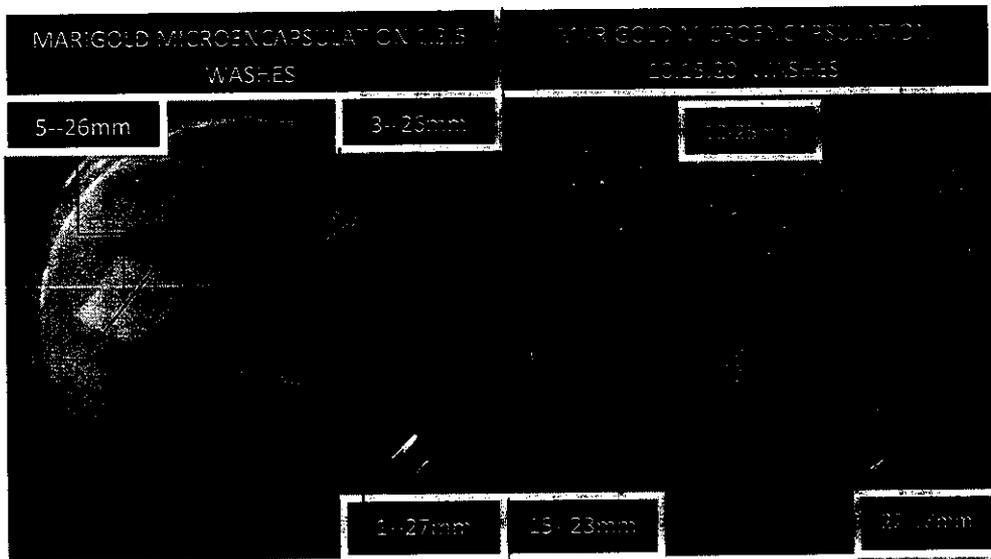
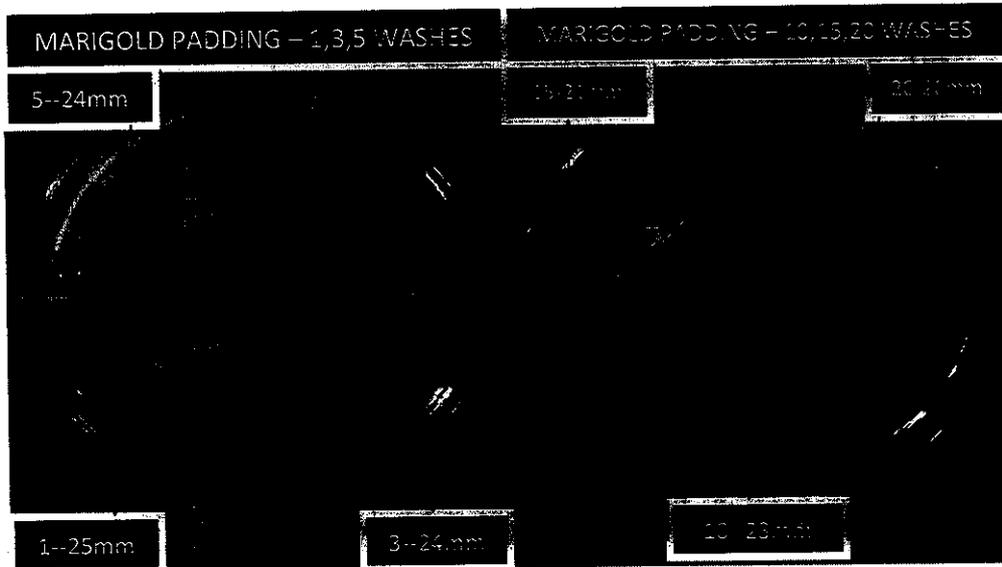


PLATE 16 – NEEM – ECOLI

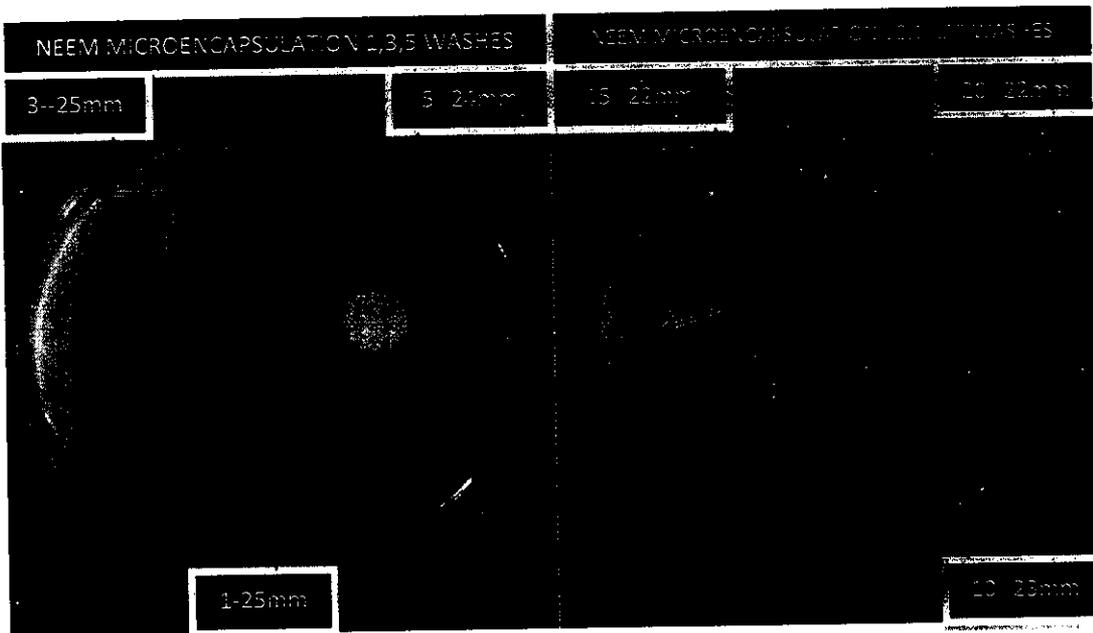
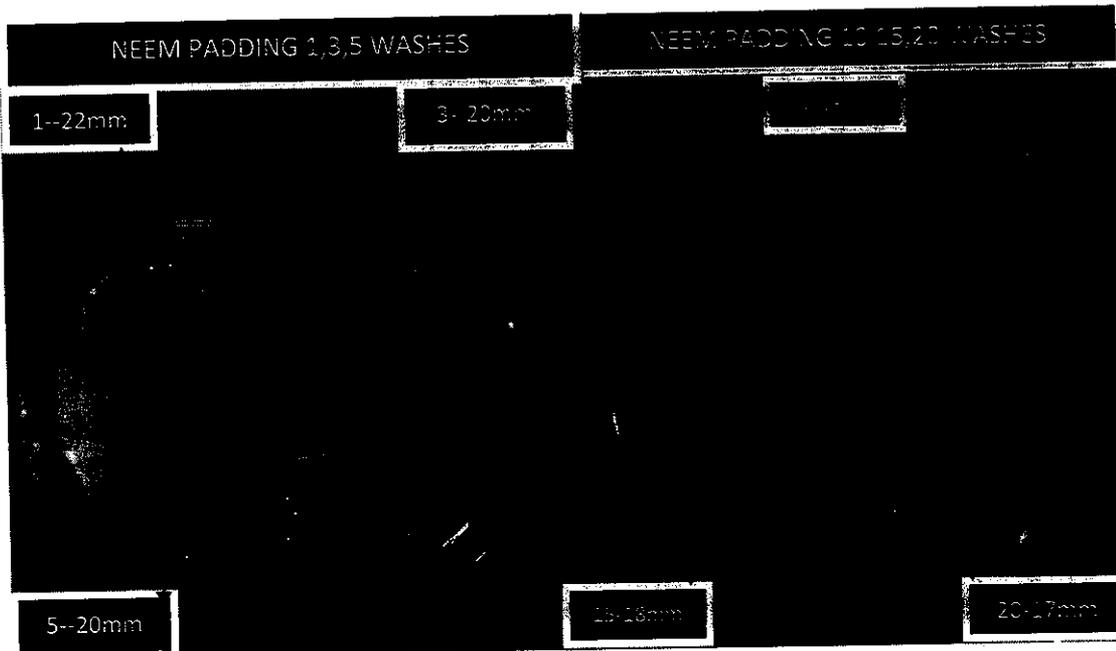


PLATE 17 - MARIGOLD - E. COLI

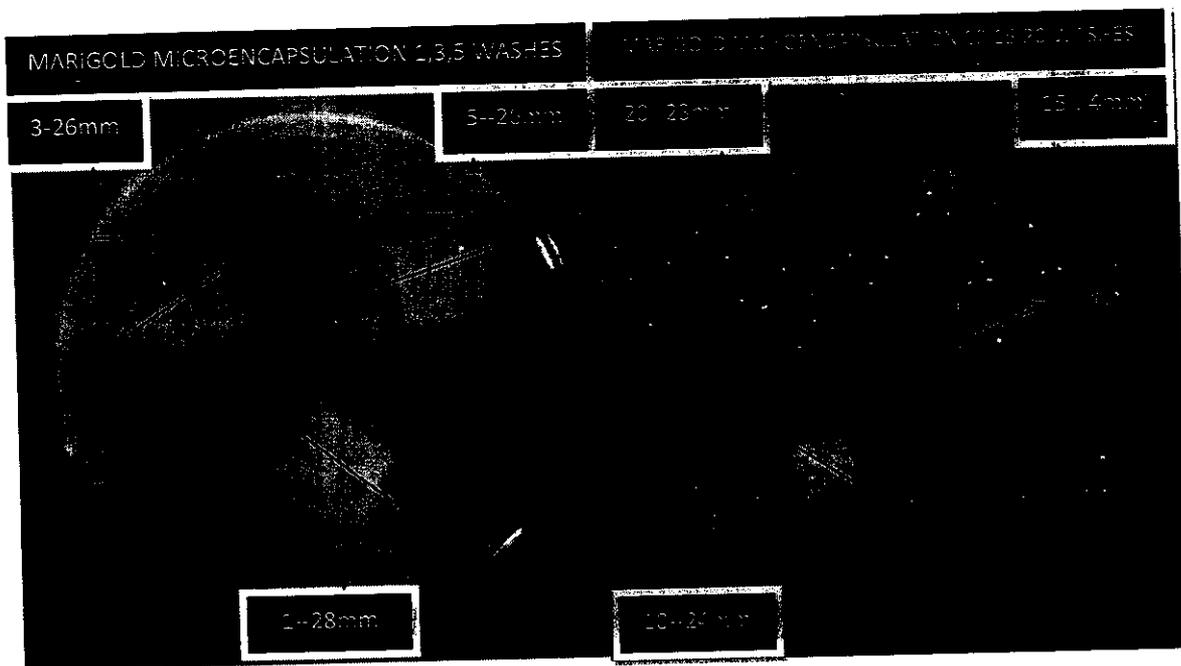
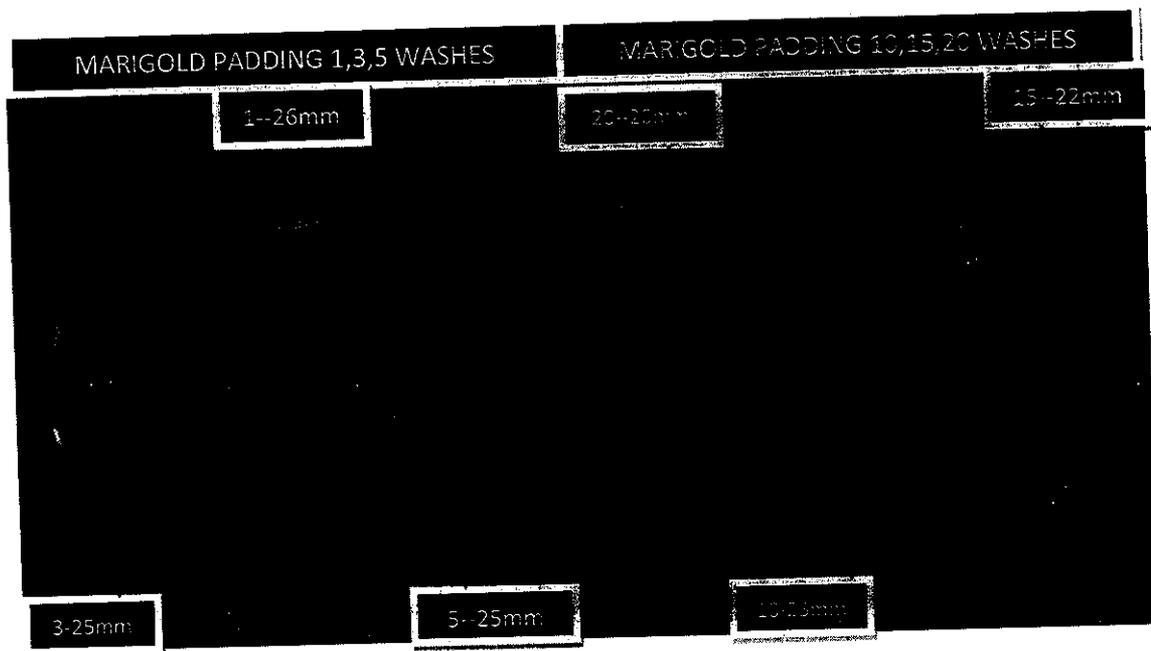


PLATE - 18

MACHINERIES USED FOR ANTIMICROBIAL TEST

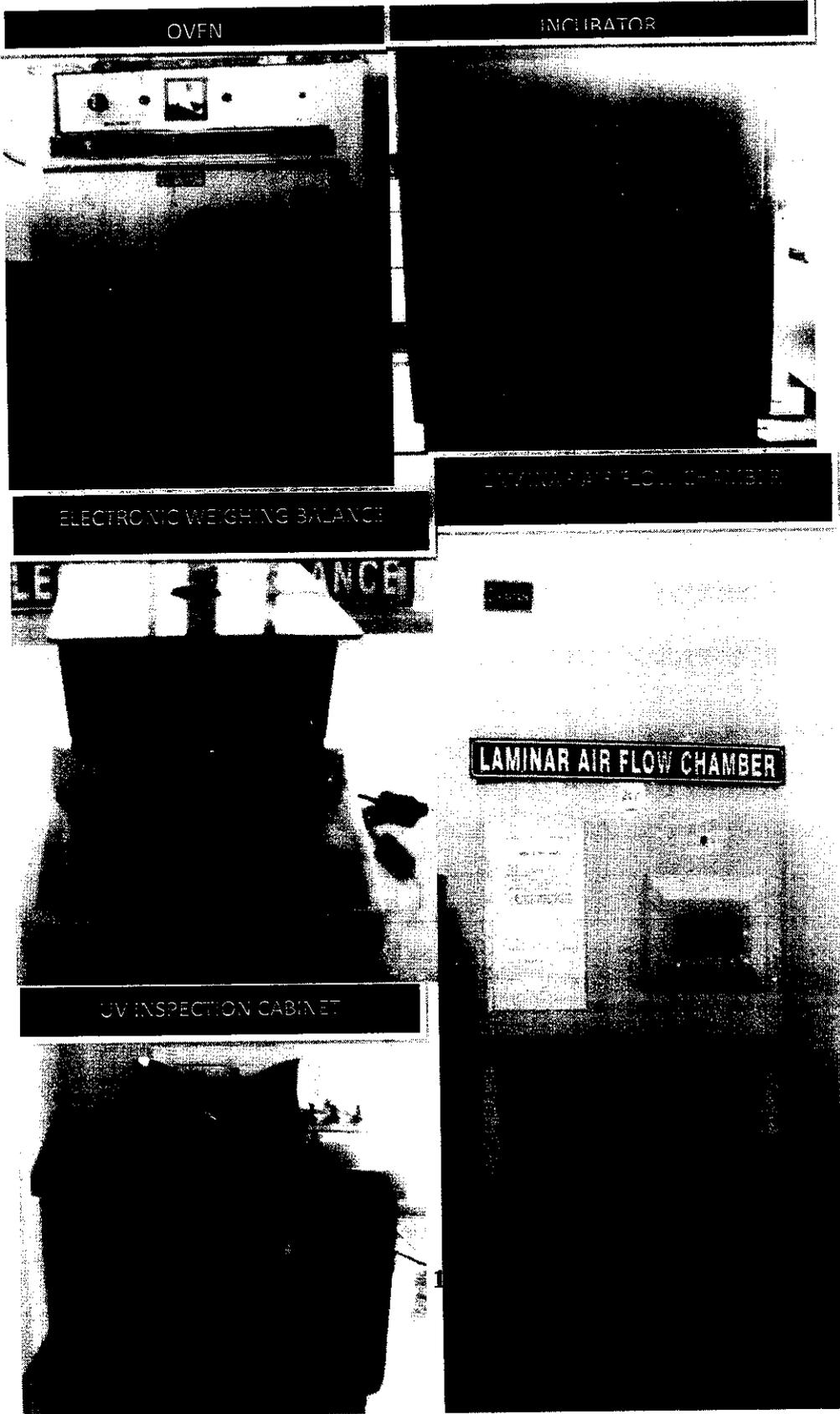


PLATE - 19 MACHINERIES USED FOR FABRIC TESTING

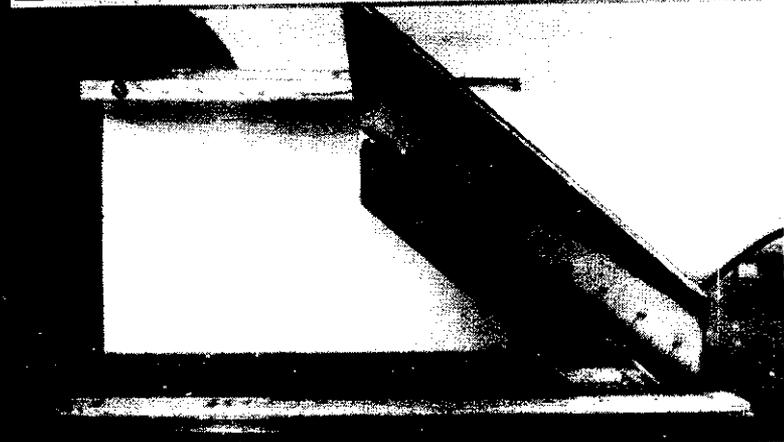
TENSILE STRENGTH TESTER



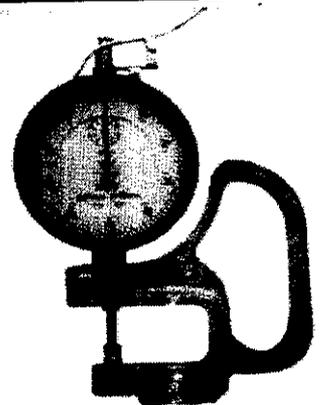
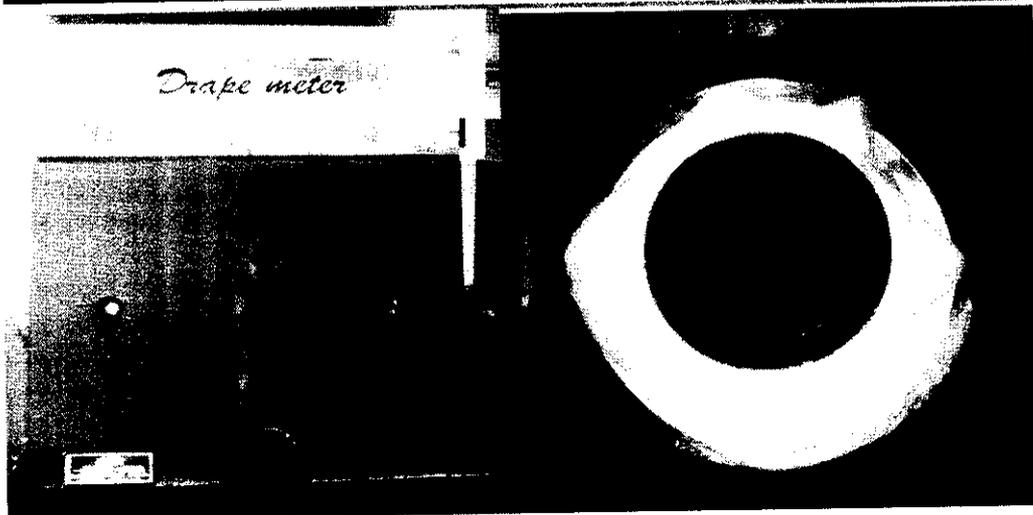
MARTINDALE ABRASION RESISTANCE TESTER



STIFFNESS TESTER



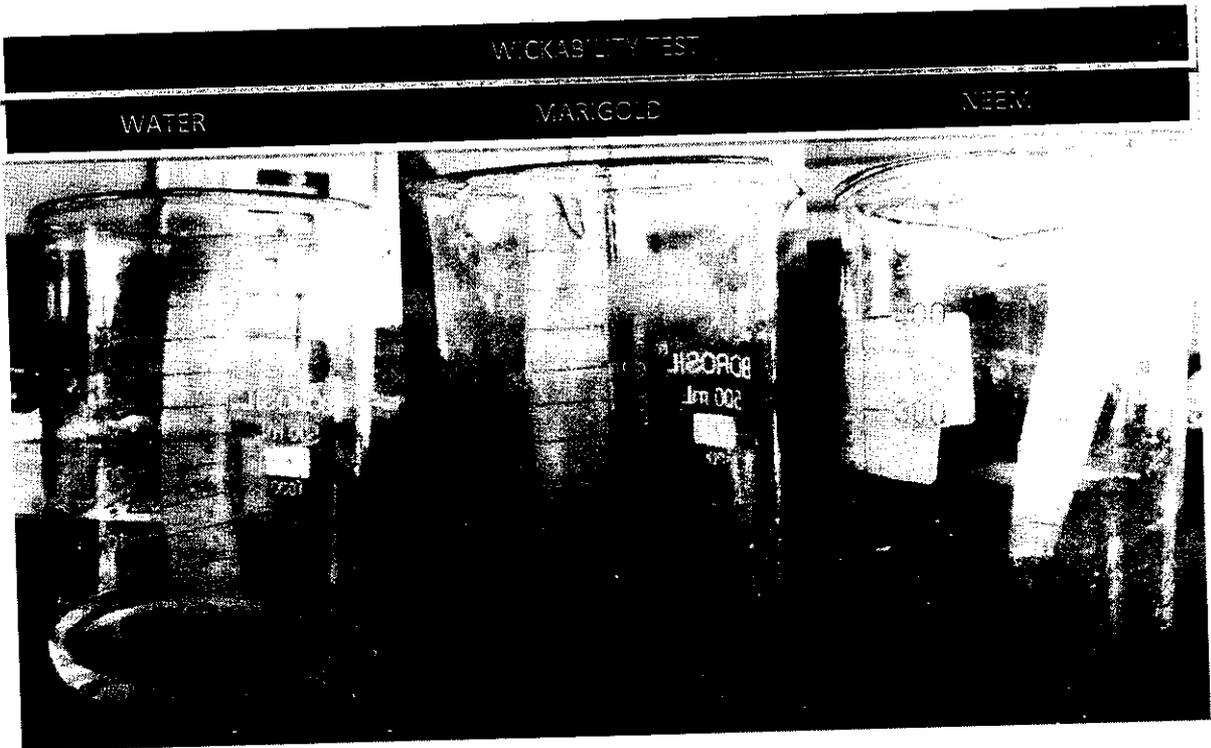
DRAPE METER



THICKNESS GAUGE

PLATE - 20

WICKING TEST



CONCLUSION

CONCLUSION

Microbial growth on textile materials has been considered as a major cause of Human beings skin and biodegradation of textiles which has led to the development of antimicrobial technologies for preservative purpose. Such studies have further stimulated the research work on antimicrobial textiles with focus on development of durable and powerful antimicrobial finishing technology. Today the world is moving in to the eco-friendly era. There is a vast resource of natural antimicrobial agents, which can be used for imparting useful antimicrobial property to textile substrates. This research work reports about the effective method for treating and curing of skin diseases with the help of natural herbal antimicrobial finished products. The herbs used are Neem for curing Dandruff and Pimples and Marigold for curing Cracked heels and Athletes foots. The anti-microbial compounds present in the herbs are identified through TLC and FTIR tests. After the flavonoids and phenolic acid compounds identification, the extracts are tested with the micro organisms like and the zone of inhibition is measured. Then the process conditions are optimized with four different solvents, three temperatures and three different concentrations, based on the orthogonal design table. Then the herbal extracts and the commercial antibiotics of antimicrobial growth are compared with the zone of inhibition in mm by using AATCC 147 agar diffusion standard test method. The herbal extracts are prepared in the ratio 1:10(1gram of herbal powder in 10ml of water) and applied on the fabric by padding and microencapsulation methods. Then various objective evaluation tests like fabric tensile strength, abrasion resistance etc, is carried out for both herbal treated fabrics and untreated fabric. Similarly the wash durability of the samples is found by treating it with staphylococcus aureus and Escherichia coli bacteria and Aspergillus Niger fungi. The formation of the microcapsules in the fabric is identified using SEM study. The finished samples using padding process last up to 15 washes where as the samples finished using Micro encapsulation technique possess high durability and last up to 20 washes. The fabric treated with Neem and marigold extract gives green and pale orange color to the fabric which does not affect the look of the product. Then the wear study was conducted for 10 persons with different skin diseases for 15 days. Comparing the objective evaluation results, the zone of inhibition and the wear study results the neem treated fabric shows a better result than the marigold treated fabric. As per the comments given by the wearer and the doctor, the products were found to be comfortable than that of the commercial products and reacts against the disease causing bacteria and fungi and

reduces dandruff, acne, cracked skin and athletes' foot. So these antimicrobial products are eco friendly and give a good effect to human skin.

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APPENDICES

APPENDIX -1

DETAILS OF FABRIC

PARTICULARS	UNTREATED FABRIC
1. Ends per inch :	82
2. Picks per inch :	66
3. Count :	60 ^s
4. GSM :	63
5. Weave :	Plain
6. Finish given :	Desized and Bleached



P-3590

UNTREATED SAMPLE

102