



DEVELOPMENT OF SHOE INSOLE
FOR DIABETIC PATIENTS

A PROJECT REPORT

Submitted by

ARCHANA.O.K 0910202003

DEEPIKA NANDHINI.P0910202006

NIHAR SULTHANA.J0910202022

KAVIBHALA.B 0910202307

in partial fulfillment for the award of the degree

of

BACHELOR OF TECHNOLOGY

in

TEXTILE TECHNOLOGY

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE 641 049

(An Autonomous Institution Affiliated to Anna University, Chennai)

MAY 2013

BONAFIDE CERTIFICATE

Certified that this project report titled "DEVELOPMENT OF SHOE INSOLE FOR DIABETIC PATIENTS" is the bonafide work of "O.K.ARCHANA, P.DEEPIKA NANDHINI, J.NIHAR SULTHANA, B. KAVIBHALA" who carried out the project under my supervision. Certified further that to the best of my knowledge the work Reported herein does not form part of any other report or report on the basis of which a degree or diploma was conferred on an earlier occasion of this or any other candidate.

SIGNATURE

SIGNATURE

Dr.BhaarathiDhurai

Mrs.S.Radika

Professor and Head

SUPERVISOR

Department of Textile Technology

Assistant Professor

Kumaraguru College of Technology

Department of Textile Technology

Coimbatore – 641 049

Kumaraguru College of Technology

Coimbatore – 641 049

Submitted for the university project examination held on

INTERNAL EXAMINAR

EXTERNAL EXAMINAR

i

ii

ACKNOWLEDGEMENT

I express my sincere gratitude Co-Chairman Dr. B. K. Krishnaraj Vanavarayar and our sincere gratitude to our Joint Correspondent Shri. K. Shankar Vanavarayar and our Principal Dr. S. Ramachandran for their support and for providing the required facilities for carrying out this study.

I also express my gratefulness to Dr.BhaarathiDhurai, Professor and Head of the Department of Fashion Technology, Kumaraguru College of Technology for extending for his timely help and encouragement throughout the project.

I wish to thank my guide, Mrs. S. Radika, Assistant Professor, Department of Textile Technology, Kumaraguru College of Technology for his valuable help, guidance, assistance and encouragement throughout the study.

I express my sincere thanks to Prof. Dr.G.Ramakrishnan, Coordinator, KCT TIFAC CORE, for his valuable guidance and facilitating us to use the facilities at KCT TIFAC CORE. We sincerely thank Mr. K. Gopinath, Senior Scientific Officer, KCT TIFAC CORE.

Last but not least my heart full gratitude to Department of Textile Technology, Kumaraguru College of Technology, our beloved parents and friends for extending the support, who helped us to overcome obstacles in the study.

iii

ABSTRACT

In recent years, terms like 'going green' and 'eco-friendly' have become buzz words on talk shows, commercials and product making. The term eco-friendly has been used for many different product practices.

Likewise we have brought our product under the shadow of eco-friendly and disposable. As the title reveals 'Development of shoe insole for diabetic patients' on the basis of natural products.

Our main product is shoe insole for a diabetic patients. The shoe insole hold the natural products such as bamboo and chitosan. Bamboo fiber being a biodegradable textile material has many antibacterial qualities. Above that chitosan has both anti-bacterial and antimicrobial performance inhibiting bacteria's growth .

Bamboo fiber is converted into web using carding machine. The web obtained is fed for needle punching. The non-woven material is made to dry and taken out and for testing. The specimen undergoes follows anti-bacterial test, wound pathogen test and the result gave good activity towards bacteria and organism like staphylococcus aureus, klebsiella, pseudomonas. Since it is a used throw material, it need not have to support sufficient mechanical properties.

iv

4.3	MECHANICAL TEST	69
	4.3.1	Wet tensile strength test 69
	4.3.1.1	Procedure 69
	4.3.1.2	Report 69
	4.3.1.3	Graphical
representation	69	
	4.3.2	Water absorption and desorption test 70
	4.3.2.1	Procedure 70
	4.3.2.2	Report 70
	4.3.2.3	Graphical representation of absorption 71
	4.3.2.4	Graphical representation of desorption 71
	4.3.3	Flexing index 72
	4.3.3.1	Procedure 72
	4.3.3.2	Report 72
6.	CONCLUSION	74
5.	REFERENCE	75

	LIST OF FIGURES	
2.1(a)	BAMBOO APPLICATIONS	6
2.1(b)	BAMBOO APPLICATIONS	7
2.1(c)	BAMBOO APPLICATIONS	7
2.2	PRAWNS	9
2.3	FOOT ULCER	13
2.4	CAUSE OF ULCER	14
2.5	DIABETIC PATIENT WITH NEUROPATHY, CALLUS AND CLAW TOES	15
2.6	FOOT ULCER	16
2.7	TOE ULCER	17
2.8	NYLON MONOFILAMENT TEST	18
2.9	THE DIFFERENT DEFORMITIES OF "AT RISK" DIABETIC FOOT	27
2.10	NEEDLE PUNCHING MACHINE	36
2.11	DIABETIC SOCKS	37
2.12	DIABETIC SHOES	39
2.13	STYLISH DIABETIC SHOE AVAILABLE IN MARKET	41
2.14	DIABETIC SHOES	42
2.15	STAPHYLOCOCCUS AUREUS	43
2.16	KLEBSIELLA	51
2.17	AGAR PLATE STREAKED WITH KLEBSIELLA PNEUMONIAE	51
2.18	PHAGOCY TOSIS OF PSEUDOMONAS AERUGINOSA	

	BY NEUTROPHIL IN PATIENT WITH BLOODSTREAM INFECTION(GRAM STRAIN)	52
4.1	GRAPHICAL REPRESENTATION OF ANTIBACTERIAL ACTIVITY	62
4.2	SEM IMAGE OF ANTIBACTERIAL TEST CARRIED ON THE SAMPLE	63
4.3	GRAPHICAL REPRESENTATION FOR ANTIBACTERIAL TEST FOR VARIABLES	64
4.4	SEM IMAGE OF ANTIBACTERIAL ACTIVITY FOR VARIABLES	65
4.5	GRAPHICAL REPRESENTATION FOR WOUND PATHOGEN TEST	67
4.6	SEM IMAGE OF WOUND PATHOGEN TEST CARRIED ON THE SAMPLE	68
4.7	GRAPHICAL REPRESENTATION FOR WET TENSILE STRENGTH TEST	69
4.8	GRAPHICAL REPRESENTATION FOR WATER ABSORPTION	71
4.9	GRAPHICAL REPRESENTATION FOR WATER DESORPTION	71

	LIST OF TABLES	
2.1	PROPERTIES AND EFFICACY OF CHITOSAN	10
4.1	INTERPRETATION OF ANTIBACTERIAL ACTIVITY	61
4.2	INTERPRETATION OF ANTIBACTERIAL ACTIVITY FOR THE VARIABLES	64
4.3	INTERPRETATION OF WOUND PATHOGEN TEST	67

INTRODUCTION

As our project title states our main aim, to provide a shoe insole for the diabetic patients in general. Till now, the manufactures has introduced only the normal shoe insoles. But we have put effort and idea to help the diabetic patients in making the feel comfort and relieve them from severe foot ulcer.

As per the need, our product holds all the basic needs and properties that a shoe insole is supposed to have. Other than that, we have also introduced wound healing measure which is very necessary for the diabetic patients.

The main aim of our product is to keep the diabetic patients free from wound caused in their foot. By making use of this product, the patient can feel a great relief from foot ulcer.

Most of the diabetic patients suffer from foot ulcer and bleeding of fluids. Now here is a solution for it. A use and throw diabetic shoe insole is introduced.

Our product holds a greatest advantage of wound healing. If the product is introduced in the market, there are more probabilities for the patients to use. Since it is a use and throw product this seems to turn as pretty worth.

1

Bamboo fabric is very soft and can be worn directly next to the skin. Many people who experience allergic reactions to other natural fibres, such as wool or hemp, do not complain of this issue with Bamboo. The fibre is naturally smooth and round without chemical treatment, meaning that there are no sharp spurs to irritate the skin. In Bamboo fabric, this translates to an excellent wicking ability that will pull moisture away from the skin, so that it can evaporate. Bamboo also has many antibacterial qualities, which Bamboo fabric is apparently able to retain, even through multiple washings, which helps in reducing the bacteria that thrive on clothing. It can also kill odour causing bacteria that live on human skin, making the wearer and his/her clothing smell sweeter. In addition, Bamboo fabric has insulating properties and will keep the wearer cooler in summer and warmer in winter. [2,3]

2.1.2 WET PROCESSING:

Singeing: Carried out in moderate condition.

Desizing: Should be consolidate & desizing rate should be over 80%.

Scouring: Pure Bamboo normally need no scouring, sometimes wash it with a little alkaline soap. The scouring process should be made in terms of contents blended with cotton. When pure Bamboo fabrics are under scouring, the alkali should not be over 10g/litre, but be applied in accordance with the thickness of fabrics.

Bleaching: The processing should be made in terms of the specification and thickness of fabrics.

3

LITERATURE SURVEY

2.1 BAMBOO:

2.1.1 INTRODUCTION:

Bamboo fibre is a natural textile made from the pulp of the bamboo grass. Fabric made with Bamboo fibre has been growing in popularity, because it has many unique properties and is more sustainable than most textile fibres. Bamboo fabric is light and strong, has excellent wicking properties, and is to some extent antibacterial. The use of bamboo fibre for clothing was a 20 century development, pioneered by several Chinese corporations. Bamboo is the fastest growing plant in this planet and has the ability to grow in many different climates, from jungles to high on mountainsides. Bamboo is just a grass, but varies in height from dwarf plant (30cm) to giant timber Bamboos (30m). Bamboo is used as the primary construction material and for making great variety of useful objects from kitchen tools to paper to dinnerware. Generally bamboos are commonly used for furniture, construction, musical instruments and many more things. Bamboo is not only highly fashionable for decorative purposes but useful too. As it is a viable replacement for wood, in far Eastern countries, it is the primary building material. Bamboo is in fact one of the strongest building materials available and even provided the first re-greening in Hiroshima after the atomic blast in 1945. [1,2]

The various advantage lies with bamboo has evolved it as a suitable textile grade material. Bamboo fabric is light & strong and has excellent wicking properties.

2

Mercerizing: The fabrics are normally free of mercerizing, due to their sound lustre and bad anti-alkaline. However, some fabrics require mercerization, in order to enhance their capacity to absorb moisture & dyestuff.

Dyeing: The most preferable dyeing process is to use the active dyestuff during dyeing. The alkali concentration & treatment temperature is tried to maintain below 20g/litre & 1000C respectively. The post dyeing operation(drying), is carried out by applying light tension under low temperature condition. [4]

2.1.3 PROPERTIES OF BAMBOO FIBRE:

Natural Anti-bacterial property: Scientist has found bamboo owns a unique anti-bacteria and bio agent named "bamboo Kun". This is the substance which is not lost after bamboo is passed through series of process for extrusion. Bamboo fiber has particular and natural functions of anti-bacteria, bacteria-stasis and deodorization. It is validated by japan textile inspection association that, even after fifty times of washing, bamboo fabric still possesses excellent function of anti-bacteria, bacteria-stasis.

Breathable and Cool: Bamboo fiber has its unusual breathability and coolness, due to its cross-sections filled with various micro gaps and micro holes and it has better ventilation and absorption. With its unparalleled micro-structure this can absorb and evaporate human sweat in a split second. It will never stick to skin even in hot summer. Bamboo apparels are 1-20C lower than normal apparels in hot summer. Bamboo apparel is crowned as "Air Conditioning Dress".

Green & Biodegradable: Raw material bamboo is well-selected from non-polluted region. They are 3-4 years older than new bamboo. The whole distilling and producing process in plan is green process without any pollution. Bamboo

4

fiber is biodegradable textile material and can be 100% biodegraded in soil by micro-organisms and sunshine. The decomposition process doesn't cause any kind of pollution to environment. "Bamboo fiber come from nature, and completely returns to nature in the end". Bamboo fiber is praised as "the natural, green and eco-friendly new type textile material of 21st century". [5]

2.1.4 BAMBOO FIBRE APPLICATIONS:

Bamboo intimate apparels: These apparels have comfortable hand, special lustre, bright colors and good water absorbance like towels, blankets, sweaters, bath suits and mats. Due to its special function as anti-bacterial it can be used in underwear, tight T-shirts, scarves, skirts and socks. Bamboo is suitable in summer mainly to the pregnant ladies and children from getting affected by ultraviolet radiations due to presence of anti- ultraviolet character.

Bamboo non-woven fabrics: They are made out of pure bamboo pulp and resemble the same properties of viscose fibers. Bamboo can be used in sanitary napkins, masks, mattress and food-packing bags due to wide prospective in the field of hygiene.

Bamboo decorative series: Bamboo has an advantageous utilization in the decorating industry. It has the function of antibiosis, bacteria-stasis and ultraviolet proof, because of the deterioration of the atmosphere pollution and destruction to the ozonosphere, the ultraviolet radiations affects us more and more. Long time exposure to UV radiations leads to skin cancers. So the wallpapers and curtains absorb all the UV radiations in various wavelength, thus helps us in getting harmed. Bamboo decorating products won't go moldy due to the damp. Curtains, sofa covers, table covers, wall hangings, bed sheets etc. are made of bamboo fiber.

Bamboo baby wear: Baby wear generally need comfort, softness, and they should not cause any type of allergies. Bamboo fiber which we use has all the properties required which the baby needs like its soft and it's a natural anti-bacterial protected. Bamboo fabrics used are generally knitted and terry towel fabrics.

Bamboo shoes: It is unique among all bamboo fiber market due to it unparalleled advantages while comparing it with others. Appearance of the bamboo shoes are very advantages to the patients suffering with foot diseases. The making of bamboo shoes include materials of bamboo, fiber& charcoal, adopting the modern high-tech means and optimizing the inside structure of shoes. The inner environment of the shoes has been ameliorates so it plays a role of anti-bacterial, bacterio-stasis, anti-mite and deodorization. Due to it special features like soft, wear-resistant and good flexibility it is comfortable for the customer.[6,7,8,9,10][11][12][13]



Fig 2.1(a) Applications

2.2 CHITOSAN POWDER:

2.2.1 INTRODUCTION:

Chitin is a natural biopolymer derived from exoskeletons of crustaceans and also from cell walls of fungi and insects. Chitosan is different from chitin; chitosan is a collective name representing a family of de-N-acetylated chitins deacetylated to different degrees. Both chitin, chitosan and their modified derivatives have been applied in medicine, agriculture, food, and non-food industries. Chitosan was introduced in the year 1990 and various sectors of medical and health industry are using its benefits. [14]

The antibacterial and antimicrobial performance is given with the inhibition of the bacteria's growth, so having an anti-smell function too. The high level of comfort, the allergenicity and the high humidity absorption (e.g. sweat) give to the clothes realized with this fiber the capability to be used to direct skin contact, as in underwear, socks, pyjama and so on.[14]

Chitosan is gaining popularity as a textile fibre which can be specifically used for medical purposes. It is a unique material with certain special properties, preferred for medical usage. It has been found that wound dressings from chitosan can increase the rate of healing by 75%. Molecular structure of chitosan is very similar to chitin and cellulose. If chitosan really can prevent the fat absorption, it can also prevent the absorption of other fat-soluble substances and negative-charged substance (chitosan is positively-charged). [14]

Chitosan, the deacetylated derivative of chitin, is a natural D-glucosamine polymer that can be extracted from the shells of seafood such as prawns, crabs and lobsters. It can be used as a wound healing promotion agent and antimicrobial agent.



Fig 2.1(b) Applications



Fig 2.1(c) Applications



Fig 2.2 Prawns

The chitosan acetate bandages work to heal wounds by becoming sticky as it contacts blood, creating a glue-like substance that controls bleeding and seals the wound tightly. These bandages control bleeding even for patients on blood thinner medication, allowing the blood to clot naturally. [14]

You can find numerous brands of chitosan nutritional supplements. Popular manufacturers include Now Foods, Good and Natural, Source Naturals and Natural Max. [14]

Chitin is one of the most abundant organic materials in nature and in fact chitosan is the partially deacetylated form of chitin. The deacetylated amino groups are responsible for the positive charge of chitosan, which makes it water soluble and reacts readily with a variety of negatively charged materials. [14]

Chitosan has enormous potential as therapeutic material due to its interesting features such as antimicrobial nature, scar prevention and biocompatibility. Chitosan is impermeable to exogenous microorganism due to its top layer and inherent antimicrobial property of chitosan and show excellent oxygen

antibacterial agents to prevent or retard the growth of bacteria is becoming a standard finishing for textile goods.

Accordingly, an ideal textile antibacterial finishing should be safe and environmentally benign besides killing undesirable micro-organisms. Chitosan, as nontoxic, biodegradable and biocompatible natural polymer, as well as having antimicrobial activity, is an ideal candidate material. [14]

2.2.5 CHITOSAN IN MEDICAL TEXTILE:

Chitosan has many useful biological properties because of its good biocompatibility. These properties, along with its abundance and easy sourcing makes it extremely fit for biomedical uses. Chitosan has high biocompatibility, bio-absorbability, wound healing property, haemostatic, anti-infection and antibacterial effects. In addition, chitosan is easy to handle for clinical uses because of its resistive nature to heating due to intra-molecular hydrogen bonding formed between the hydroxyl and amino groups. Therefore, much attention has been paid to chitosan-based biomedical materials, for example, drug delivery carriers, wound healing agents, etc. However, clinical applications are limited due to low mechanical strength. Fibres from chitosan have been useful for absorbable sutures and wound dressings. It has been claimed that wound dressings from chitosan fibres accelerate the healing of wounds by 75%. Chitosan has also been applied successfully in artificial kidney systems and artificial skin.

An ideal wound dressing material must be capable of absorbing the exuded liquid from the wounded area and should permit water evaporation at a certain rate and allow no microbial transport. As a key parameter regarding wound dressing, the antimicrobial property assessment is necessary. Chitosan, owning hydrogel-

permeability, controlled evaporative water loss and enhanced fluid drainage ability. [14]

2.2.2 PROPERTIES:

- Very strong antibacterial effect
- Total biodegradability
- Biocompatibility (anallergicity)
- High humidity absorption [14]

2.2.3 PROPERTIES AND EFFICACY OF CHITOSAN:

Table 2.1 Properties and efficacy of chitosan

Biodegradation	Being an organic material, the chitosan is degraded by microorganisms
Antimicrobial Activity	Inhibits bacterial growth
Body Activation	Accelerates wound healing
Slow Releasing Action	Permits slow and steady release of medicines maximizing the efficacy

2.2.4 APPLICATION IN TEXTILE INDUSTRY:

Antimicrobial treatment is increasingly becoming a standard finish for some textile products such as for medical, institutional and hygienic uses. Natural textiles such as those made from cellulose and protein fibers are often considered to be more vulnerable to microbial attack than man-made fibers in light of their hydrophilic porous structure and moisture transport characteristics. Thus, the use of

forming properties have been considered to be advantageous in their application as a wound dressing materials. Chitosan-based materials have received much attention in this regard.

Typically, there are four forms in which chitosan provides antimicrobial effect to wound dressing materials: fiber, membrane, sponge and hydrogel. Majority of antimicrobial products perform their talent in fabric form. [14]

2.3 DIABETIC FOOT ULCER:

2.3.1 Diabetic Foot Ulcer:

A diabetic foot ulcer is an open sore or wound that most commonly occurs on the bottom of the foot in approximately 15% of patients with diabetes. Of those who develop a foot ulcer, approximately 6% will be hospitalised due to infection or other ulcer-related complication. It may take weeks or even several months for your foot ulcers to heal. Diabetic ulcers are often painless. [15]

2.3.2 Causes of diabetic foot ulcers:

Diabetic foot ulcers are caused by neuropathic (nerve) and vascular (blood vessel) complications of the disease.

Nerve damage due to diabetes causes altered or complete loss of feeling in the foot and/or leg. This is known as peripheral neuropathy. Pressure from shoes, cuts, bruises, or any injury to the foot may go unnoticed. The loss of protective sensation stops the patient from being warned that the skin is being injured and may result in skin loss, blisters and ulcers.

Vascular disease is also a major problem in diabetes and especially affects very small blood vessels feeding the skin (microangiopathy). In this situation a doctor may find normal pulses in the feet because the arteries are unaffected. However other diabetic patients may also have narrowed arteries so that no pulse can be found in the feet (ischaemia). The lack of healthy blood flow may lead to ulceration. Wound healing is also impaired.

Vascular disease can complicate a foot ulcer, reducing the body's ability to heal and increasing the risk for an infection. Elevations in blood glucose can reduce the body's ability to fight off a potential infection and also retard healing.

Vascular disease is aggravated by smoking.

Diabetes is the leading cause of non-traumatic lower extremity amputations in the developed world, and approximately 14 to 24% of patients with diabetes who develop a foot ulcer have an amputation. Research, however, has shown that the development of a foot ulcer may be preventable. [15][16]



Fig 2.3 Foot ulcer

In 1995, it was estimated that there were 135 million individuals worldwide with this disease, a figure that is likely to have risen to 154 million by 2000. By 2025, it is projected there will be 300 million individuals with diabetes across the world. The vast majority of new cases will be type 2 (non-insulin-dependent) diabetes, with a 42% increase of cases in developed countries and a 170% increase in developing countries.[27]

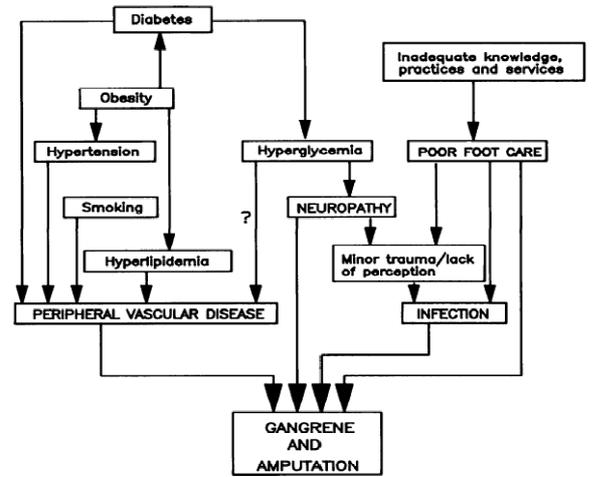


Fig 2.4 Causes of ulcer



Fig 2.5 Diabetic patient with neuropathy, callus and claw toes

2.3.3 TYPES:

There are three types of foot ulcers: venous stasis ulcers, which are the most common type, arterial and neurotrophic ulcers, which are caused by diabetes. According to the Cleveland Clinic, about 90 percent of ulcers are venous stasis. Arterial are typically the most painful.[17]

2.3.4 IDENTIFICATION:

Each type of ulcer looks a bit different.

- **Venous stasis ulcers** are usually found around the ankle area, can appear red, and have an asymmetrical shape. They also may drain out fluid. The skin around the ulcer may feel hot, according to the Cleveland Clinic.
- **Arterial ulcers occur** on the foot, even on the toes, and may not bleed.
- **Neurotrophic ulcers** occur on the bottom of the feet, and may appear pink or even black, depending on the condition of the ulcer. Amazingly, some people with neurotrophic ulcers may not even realize they have one, which

makes them even more dangerous, because they can often become very infected before any treatment begins. [18]

2.3.5 FORMATION OF DIABETIC FOOT ULCERS:

Ulcers form due to a combination of factors, such as lack of feeling in the foot, poor circulation, foot deformities, irritation (such as friction or pressure), and trauma, as well as duration of diabetes. Patients who have diabetes for many years can develop neuropathy, a reduced or complete lack of feeling in the feet due to nerve damage caused by elevated blood glucose levels over time. The nerve damage often can occur without pain and one may not even be aware of the problem.[16]



Fig 2.6 Foot ulcer

Your healthcare professional can test feet for neuropathy with a simple and painless tool called a monofilament.

2.3.6 WHO CAN GET A DIABETIC FOOT ULCER?

Anyone who has diabetes can develop a foot ulcer, older men are more likely to develop ulcers. People who use insulin are at a higher risk of developing a foot ulcer, as are patients with diabetes-related kidney, eye, and heart disease. Being overweight and using alcohol and tobacco also play a role in the development of foot ulcers. [16]



Fig 2.7 Toe ulcer

2.3.7 WHO IS AT RISK OF DIABETES?

Be tested for diabetes if you are:

- over 40 years of age
- overweight
- have a family history of diabetes
- had gestational diabetes or
- are at high ethnic risk [17]

17

2.3.8 SIGNS AND SYMPTOMS:

It is not unusual for patients to have had diabetic foot ulcers for some time before presenting to doctors because they are frequently painless.

Tissue around the ulcer may become black due to the lack of healthy blood flow to the foot. In severe cases partial or complete gangrene may occur.

Diabetics are also very prone to secondary infection of the ulcer (wound infection) and surrounding skin (cellulitis).

Nylon Monofilament Test: There is a risk of ulcer formation if the patient is unable to feel the monofilament when it is pressed against the foot with just enough pressure to bend the filament. The patient is asked to say "yes" each time he or she feels the filament. Failure to feel the filament at four of 10 sites is 97% sensitive and 83% specific for identifying loss of protective sensation. [17]

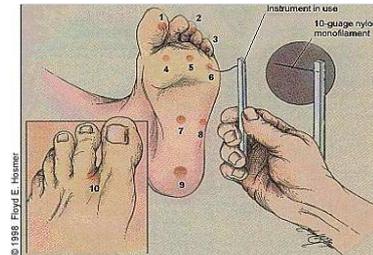


Fig 2.8 Nylon monofilament test

2.3.9 DIABETIC AFFECTED FEET:

18

1. Loss of sensation(peripheral neuropathy).

- Injuries occur without pain.
- People delay seeking help.
- Peripheral neuropathy also contributes to muscle weakness and foot deformities.

2. Poor circulation

- Pain in calf muscles when walking or climbing stairs/incline
- Burning pain in feet at night
- Poor healing of wounds on the feet and legs

3. Stiffening of the joints

4. Muscle weakness

5. Foot deformities

6. Skin changes

7. Slower healing due to high blood sugar [28]

The prevention of foot ulcers involves losing weight, if one is at a risk for diabetes. Smoking also increases the risk of diabetes, and, in turn, the risk of foot ulcers, so quitting is a preventive measure, as well. If diabetes has already been diagnosed, making sure foot hygiene is well maintained is important, as well as wearing proper shoes with the right support.

Prevention for ulcer in people who are at high risk:

Self care:

- Daily foot inspection to check for injuries
- Apply moisturizing cream to dry skin to prevent cracked skin and fissures
- No walking barefoot
- Avoidance exposing feet to sources of heat
- Eg: electric blankets, hot water bottles, heaters

First Aid:

- Clean with water, apply dressing, rest the area and seek help if not healed in 48 hours.
- See a podiatrist for regular treatment of toenail abnormalities, calluses etc.

Choosing the right shoes:

- Leather upper
- Deep and wide enough at the toe to fit toes
- Round toe with 1 thumb width at the end
- Firm, enclosed heel counter (no sling backs)
- Laces (or velcro) to keep the foot from sliding
- Flexible rubber soles 5-10mm thick
- No rough seams inside [18]

2.3.10 FOOT RISK ASSESSMENT:

- Check for nerve damage
- Check for poor circulation
- Examine feet for skin, joint and nail problems

Assess footwear [18]

2.3.11 PREVENTION:

19

20

2.3.12 SOME COMMON FOOT PROBLEMS WITH DIABETES:

Anyone can get the foot problems listed below. For people with diabetes, however, these common foot problems can possibly lead to infection and serious complications, such as amputation.

- **Athlete's foot:** Athlete's foot is a fungus that causes itching, redness, and cracking. Germs can enter through the cracks in your skin and cause an infection. Medicines that kill the fungus are used to treat athlete's foot. These medicines may be pills and/or creams applied directly to the problem area. Ask your doctor to recommend a medication for athlete's foot.
- **Fungal infection of nails:** Nails that are infected with a fungus may become discolored (yellowish-brown or opaque), thick and brittle, and may separate from the rest of the nail. In some cases, the nail may crumble. The dark, moist, and warm environment of shoes can promote fungal growth. In addition, an injury to the nail can put you at risk for a fungal infection. Fungal nail infections are difficult to treat. Medications applied directly to the nail are available, but they only help a small number of fungal nail problems. Oral medications (pills) may need to be prescribed by your doctor. Treatment also may include periodic removal of the damaged nail tissue.
- **Calluses:** A callus is a build-up of hard skin, usually on the underside of the foot. Calluses are caused by an uneven distribution of weight, generally on the bottom of the forefoot or heel. Calluses also can be caused by improperly fitting shoes or by a skin abnormality. Keep in mind that some degree of callus formation on the sole of the foot is normal. Proper care is necessary if you have a callus. After your bath or shower, use a pumice stone to gently remove the build-up of tissue. Use

21

- **Foot ulcers:** A foot ulcer is a break in the skin or a deep sore, which can become infected. Foot ulcers can result from minor scrapes, cuts that heal slowly or from the rubbing of shoes that do not fit well. Early intervention is important in treatment. Ask your doctor for advice on how to best care for your wound.
- **Hammertoes:** A hammertoe is a toe that is bent because of a weakened muscle. The weakened muscle makes the tendons (tissues that connect muscles to bone) shorter, causing the toes to curl under the feet. Hammertoes can run in families. They can also be caused by shoes that are too short. Hammertoes can cause problems with walking and can lead to other foot problems, such as blisters, calluses, and sores. Splinting and corrective footwear can help in treating them. In severe cases, surgery to straighten the toe may be necessary.
- **Ingrown toenails:** Ingrown toenails occur when the edges of the nail grow into the skin. They cause pressure and pain along the nail edges. The edge of the nail may cut into the skin, causing redness, swelling, pain, drainage, and infection. The most common cause of ingrown toenails is pressure from shoes. Other causes include improperly trimmed nails, crowding of the toes and repeated trauma to the feet from activities such as running, walking, or doing aerobics. Keeping your toenails properly trimmed is the best way to prevent ingrown toenails. If you have a persistent problem or if you have a nail infection, you may need a doctor's care. Severe problems with ingrown nails may be corrected with surgery to remove part of the toenail and growth plate.
- **Plantar warts:** Plantar warts look like calluses on the ball of the foot or on the heel. They may appear to have small pinholes or tiny black spots in the center. The warts are usually painful and may develop singly or in clusters. Plantar warts are caused by a virus that infects the outer layer of skin on the soles of the feet. DO

23

cushioned pads and insoles in your shoes. Medications also may be prescribed to soften calluses. DO NOT try to cut the callus or remove it with a sharp object.

- **Corns:** A corn is a build-up of hard skin near a bony area of a toe or between toes. Corns may be the result of pressure from shoes that rub against the toes or cause friction between the toes. Proper care is necessary if you have a corn. After your bath or shower, use a pumice stone to gently remove the build-up of tissue. Do not use over-the-counter remedies to dissolve corns. DO NOT try to cut the corn or remove it with a sharp object.
- **Blisters:** Blisters can form when your shoes rub the same spot on your foot. Wearing shoes that do not fit properly or wearing shoes without socks can cause blisters, which can become infected. When treating blisters, it's important not to "pop" them. The skin covering the blister helps protect it from infection. Use an antibacterial cream and clean, soft bandages to help protect the skin and prevent infection.
- **Bunions:** A bunion forms when your big toe angles in toward the second toe. Often, the spot where your big toe joins the rest of the foot becomes red and callused. This area also may begin to stick out and become hard. Bunions can form on one or both feet. They may run in the family, but most often are caused by wearing high-heeled shoes with narrow toes. These shoes put pressure on the big toe, pushing it toward the second toe. The use of felt or foam padding on the foot may help protect the bunion from irritation. A device also may be used to separate the big and second toes. If the bunion causes severe pain and/or deformity, surgery to realign the toes may be necessary.
- **Dry skin:** Dry skin can crack, which can allow germs to enter. Use moisturizing soaps and lotions to help keep your skin moist and soft.

22

NOT use over-the-counter medications to dissolve the wart. If you are not sure if you have a plantar wart or a callus, let your doctor decide. [15]

2.4 SHOE INSOLE:

The insole is the inside part of the shoe that runs underneath the sole (bottom) of the foot. Insoles can usually be easily removed and whereas will sometimes replace the manufacturer's insole with speciality insoles they have purchased separately. Insoles are also sometimes refer to as footbeds, inner soles or innersoles. The insole measurement is the width of the inside of a shoe. This is used to determine the width size for feet. The insole measurement is also used to determine replacement or additional insoles that can be inserted into a shoe. In many cases this is for support and comfort.

An insole is the flat cushioning interface between the shoe and your foot. Because a common insole is basically a flat pad, and not shaped like your foot, it offers zero support, and frankly, precious little cushioning. Whatever benefits it does offer won't last long because common insoles can wear down quickly. Just how quickly depends upon the person, the shoe and the use. Shoe inserts and orthotics are frequently used to relieve a wide variety of lower extremity ailments, including ankle or knee pain or, more specifically, plantar fasciitis, posterior tibial syndrome, Achilles tendonitis, patellar femoral pain syndrome or osteoarthritis. These pathologies are particularly frequent in populations that perform highly demanding physical activities such as running or military training. The effect of shoe inserts and orthotics is still debated. Many studies claim that 50–90% of patients who were treated with orthotics reported complete relief or great improvement of their condition. Shoe inserts and orthotics can be characterized by their shape and

24

material properties, which are assumed to be essential for their effect on lower extremity ailments. It has been suggested that shoe inserts and orthotics reduce the symptoms of injuries by realigning the foot or by the cushioning effect of the insert material. The realigning effect of shoe inserts and orthotics is still controversial. However, prospective studies showed that shock absorbing.

Shock-absorbing shoe inserts also reduced the soreness in the lower extremities and back for soccer referees. These results imply that the material characteristics of shoe inserts are important features for injury prevention. Footwear comfort must be different for different individuals. Thus, a footwear condition that is comfortable to some people may be uncomfortable to others. Therefore, it is speculated that functional groups of subjects with similar characteristics and same preferences of shoe inserts exist.

The main location for stress fractures and pain for the insert and control group were the foot, knee, and lower back regions. However, the fact that in the current study inserts of different shapes and materials reduced injury frequency suggests that shock absorption may not be the major aspect of injury reducing inserts. running shoes where the thickness of material ranges from 15 to 20 mm, and, thus, the effect of differences in material may be even more distinct. The use of cushioned or shock-absorbing insoles has been suggested as a mechanism to reduce the impact forces associated with running, thereby protecting against overuse injuries. The purpose of this study was to determine whether the use of cushioned insoles reduced impact forces during running in healthy subjects. During running, loads equaling 1.5 to 5 times body weight are repetitively absorbed through each leg. It has been suggested that this repetitive loading and associated impact shocks cause microtrauma to the underlying tissues and may eventually cause enough damage to impair function. The use of cushioned or shock-absorbing

insoles has been suggested as a mechanism to reduce the impact forces associated with running, thereby protecting against these overuse injuries. Some investigations have found that the use of cushioned insoles reduces the risk of stress fractures and overuse injuries. 3-mm-thick insoles and 6mm thick insoles were found to have similar impact-attenuating properties. Many materials used in footwear lose their effectiveness in a relatively short time, depending on the patient's activity. Therefore regular replacement of the insoles atleast three times a year is necessary, insoles must be custom-molded and shock absorbing. In addition insole reduces shear stress since the total contact minimises the horizontal and vertical foot replacement.

For patients with diabetics foot complications are an ever present risk. However it is possible to design a plan for keeping the feet as healthy as possible. It is important for the patient to learn as much as possible about diabetic footcare and to take an active role in medical decisions and care. While routine medical examinations are important, every day foot care plays the biggest role in stopping foot complications before they start.

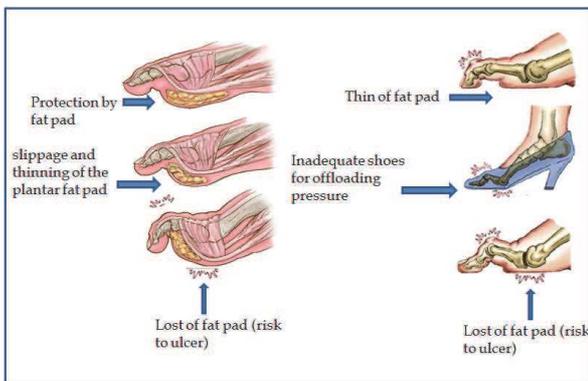


Fig 2.9The different deformities of “at risk” diabetic foot.

Shoes for the patients at risk for ulceration should have certain characteristics. High heel shoes are completely inappropriate, as they shift the body weight towards the forefoot and increase the pressure under the metatarsal heads.

Patients with toe deformities need shoe with enough room at the toe box to prevent friction and pressure on the dorsum of the toes. Foot deformities is defined according to the international consensus on the diabetic foot as ‘the presence of structural abnormalities of the foot such as presence of hammer toes, claw toes, hallux valgus, prominent metatarsal, status–post neuro-osteoarthopathy, amputations or other foot surgery.

The patients shoe should be snug, not tight and the socks should be cotton, loose fitting and change every day. Patients who have mis-shapen feet or have had a previous foot ulcer may benefit for the use of special customised shoe.

The insole provides cushioning and weight distributing function to take pressure off any residual pressure point of the plantar surface, as could be in the case of any diabetic shoe insole. The insole is also modified to attach toe filler to it to block out the area of the missing forefoot. It reduces or eliminates the side to side and front to back movement or the foot inside the shoe, which can cause friction that leads to further breakdown.

Ulcers occur at the location of the highest horizontal shear force and also at the location of the highest vertical force. The mechanism involved in diabetic foot ulceration is high fore foot pressure linked with plantar foot ulcerations. It is the combination of insensitivity and abnormally high loading of the metatarsal heads that leads to ulceration. Special shoe insoles and shoes have been developed to reduce the fore foot high pressures for diabetic patients. [25]

2.5 NONWOVEN FABRIC:

2.5.1 NONWOVEN FABRIC:

Nonwoven fabrics are broadly defined as sheet or web structures bonded together by entangling fiber or filaments (and by perforating films) mechanically, thermally, or chemically. They are flat, porous sheets that are made directly from separate fibers or from molten plastic or plastic film. They are not made by weaving or knitting and do not require converting the fibers to yarn. [19]

2.5.2 NONWOVEN FABRIC USAGE:

Beyond simple definitions, these engineered fabrics open up a world of innovative possibilities for all types of industries.

Nonwovens may be a limited-life, single-use fabric or a very durable fabric. Nonwoven fabrics provide specific functions such as absorbency, liquid repellency, resilience, stretch, softness, strength, flame retardancy, washability, cushioning, filtering, bacterial barriers and sterility. These properties are often combined to create fabrics suited for specific jobs while achieving a good balance between product use-life and cost. They can mimic the appearance, texture and strength of a woven fabric, and can be as bulky as the thickest paddings. [19]

2.5.3 PROPERTIES OF NONWOVEN FABRIC:

- Absorbency
- Bacterial barrier
- Cushioning
- Filtering
- Flame retardancy
- Liquid repellency
- Resilience
- Softness
- Sterility
- Strength
- Stretch

29

- Roofing
- Sterile medical-use products
- Tags
- Upholstery
- Wall coverings

Nonwoven fabric is a fabric-like material made from long fibres, bonded together by chemical, mechanical, heat or solvent treatment. The term is used in the textile manufacturing industry to denote fabrics, such as felt, which are neither woven nor knitted. Nonwoven materials typically lack strength unless densified or reinforced by a backing. In recent years, nonwovens have become an alternative to polyurethane foam. [19]

2.5.4 APPLICATIONS:

Nonwoven fabrics are broadly defined as sheet or webstructures bonded together by entangling fibre or filaments (and by perforating films) mechanically, thermally or chemically. They are flat, porous sheets that are made directly from separate fibres or from molten plastic or plastic film. They are not made by weaving or knitting and do not require converting the fibres to yarn. Typically, a certain percentage of recycled fabrics and oil-based materials are used in nonwoven fabrics. The percentage of recycled fabrics vary based upon the strength of material needed for the specific use. Conversely, some nonwoven fabrics can be recycled after use, given the proper treatment and facilities. For this reason, some consider nonwovens a more ecological fabric for certain applications, especially in fields and industries where disposable or single use products are important, such as hospitals, schools, nursing homes and luxury accommodations.

31

- Washability

Today, innovations in nonwoven fabrics are growing as rapidly as the demand for them, with almost unlimited possibilities for a wide variety of industries, including:

- Agricultural coverings
- Agricultural seed strips
- Apparel linings
- Automotive headliners
- Automotive upholstery
- Carpeting
- Civil engineering fabrics
- Civil engineering geotextiles
- Disposable diapers
- Envelopes
- Filters
- House wraps
- Household & personal wipes
- Hygiene products
- Insulation
- Labels
- Laundry aids

30

Nonwoven fabrics are engineered fabrics that may be a limited life, single-use fabric or a very durable fabric. Nonwoven fabrics provide specific functions such as absorbency, liquid repellence, resilience, stretch, softness, strength, flame retardancy, washability, cushioning, filtering, use as a bacterial barrier and sterility. These properties are often combined to create fabrics suited for specific jobs, while achieving a good balance between product use-life and cost. They can mimic the appearance, texture and strength of a woven fabric and can be as bulky as the thickest paddings. In combination with other materials they provide a spectrum of products with diverse properties, and are used alone or as components of apparel, home furnishings, health care, engineering, industrial and consumer goods.

Non-woven materials are used in numerous applications, including:

Hygiene:

- baby diapers or nappies
- feminine hygiene
- adult incontinence products
- wet wipes
- bandages and wound dressings
- disposable bath and face towels
- disposable slippers and footwear

Medical:

- isolation gowns
- surgical gowns
- surgical drapes and covers
- surgical scrub suits

32

- caps
- medical packaging: porosity allows gas sterilization
- gasoline, oil and air - including HEPA filtration
- water, coffee, tea bags
- pharmaceutical industry
- mineral processing
- liquid cartridge and bag filters
- vacuum bags
- allergen membranes or laminates with non-woven layers

Geotextiles:

- soil stabilizers and roadway underlayment
- foundation stabilizers
- erosion control
- canals construction
- drainage systems
- geomembrane protection
- frost protection
- agriculture mulch
- pond and canal water barriers
- sand infiltration barrier for drainage tile

Other:

- carpet backing, primary and secondary
- composites
- marine sail laminates
- tablecover laminates

33

- chopped strand mat
- backing/stabilizer for machine embroidery
- packaging where porosity is needed
- insulation (fiberglass batting)
- pillows, cushions, and upholstery padding
- batting in quilts or comforters
- consumer and medical face masks
- mailing envelopes
- tarps, tenting and transportation (lumber, steel) wrapping
- disposable clothing (foot coverings, coveralls)
- weather resistant house wrap [19]

2.5.5 MANUFACTURING PROCESS:

Nonwovens are typically manufactured by putting small fibres together in the form of a sheet or web (similar to paper on a paper machine), and then binding them either mechanically (as in the case of felt, by interlocking them with serrated needles such that the inter-fibre friction results in a stronger fabric), with an adhesive, or thermally (by applying binder (in the form of powder, paste, or polymer melt) and melting the binder onto the web by increasing temperature). [19]

2.6 NEEDLE PUNCHING:

2.6.1 NEEDLE PUNCHING PROCESS:

Needle punch non-woven fabric production line is one kind of methods for producing non-woven fabrics. In the process of producing, instead of using the traditional weaving process of the fabrics, the needle punch bond method uses triangle needles averagely punching in the cotton web to make the fibers directly tangle each other together; controlling the density, intensity, and function of the fabrics by needle density, needle depth, needle number, and other physical elements. No water, air, heat and chemicals are needed at all. It is a kind of pure physical and mechanical bonding method, saving energy and non-pollution. Finished products maintain 100% yield form ram materials. It is the best green products for environmental protection. And finally it still can be 100% recycled by physical disposal and can be reused. The products made by needle punch bond method are with 3 dimensions' (3D) effect, with excellent flexibility, and accessible to extension for processing into mold. Furthermore, it is with good ventilation, which the various traditional fabrics can't be with. The same equipment can be used for various fiber materials, including artificial fiber, synthetic fiber, recycled fiber, inorganic fiber, and metal fiber. The scope of raw materials that can be used is wide and the products that can be produced are almost limitlessly diversified. According to individual industrial requirement, the fabrics can be made into various materials for their special functions. The range of usage is very extensive. It can be used for livelihood products, industrial products, hi-tech aviation. Industrial products, and even national defense industrial products. [20][21]

35



Fig 2.10 Needle punching machine

2.7 DIABETIC SOCKS:

2.7.1 DIABETIC SOCKS:

A diabetic sock is a non-binding and non-elasticated sock which is designed so as to not constrict the foot or leg. Typically sufferers of diabetes are the most common users of this type of sock. Diabetes raises the blood sugar level, which can increase the risk of foot ulcers. Diabetic socks are made to be unrestrictive of circulation.

Some diabetic socks also control moisture, a feature which can reduce the risk of infection. Another beneficial feature of diabetic socks is seamless toe-closures to reduce pressure and blistering. [22,23]

2.7.2 CHOOSING A DIABETIC SOCKS:

Various sock constructions are available, including cotton blend with stretch tops, non-cotton with antimicrobial properties, compression type, and plain non-binding to allow circulation to flow more freely. Extra wide socks are available for excessive edema.

Diabetic socks may appear like regular socks, and are available in both low-cut and mid-calf styles. Although various colors are available, white may be preferable for people with open wounds or sores, as this could alert wearers with compromised

34

sensation to a draining wound. The diabetic socks should fit well, without constricting cuffs, lumps, or uncomfortable seams. The socks are generally made of material that does not wrinkle. The advice of a podiatrist may be helpful in choosing a diabetic sock. [23,24]

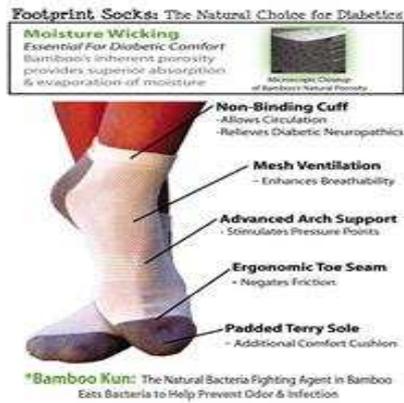


Fig 2.11 Diabetic socks

2.7.3 What are diabetic socks and what do they do?

removable orthotic. Foot orthotics are the devices such as shoe inserts, arch supports, or shoe fillers such as lifts, wedges and heels. The diabetic shoes and custom-molded inserts work together as a preventative system to help diabetics avoid foot injuries and improve mobility. [25]



Fig 2.12 Diabetic shoes

Diabetic shoes provide a wide-open market of potential new customers. At some point or another, most will also need other products you offer. Approximately 10.9

The generic answer is to protect your foot and prevent complications like infections and amputations. It is the design of the sock that is useful to the diabetic. I am not sure that the socks were invented specifically for diabetics, but they certainly are useful and the name has stuck and become a standard in the sock business.

Diabetic socks are a non-binding type of sock. They are loosely knit and have a lot of stretch in the part that covers the ankle and calf. The bottoms normally have extra padding and the socks are usually designed to have no seams or very smooth seams. They are made in such a way that the skin can breathe easily and some have special moisture-wicking capabilities. That is the mechanical properties of the socks. These properties make them useful to people suffering with many foot and leg characteristics. [23]

2.8 DIABETIC SHOES:

2.8.1 DIABETIC SHOES:

Diabetic shoes, sometimes referred to as extra depth or therapeutic shoes, are specially designed shoes, or shoe inserts, intended to reduce the risk of skin breakdown in diabetics with co-existing foot disease.

People with diabetic neuropathy in their feet may have a false sense of security as to how much at risk their feet actually are. An ulcer under the foot can develop in a couple of hours. The primary goal of therapeutic footwear is to prevent complications, which can include strain, ulcers, calluses, or even amputations for patients with diabetes and poor circulation. In addition to meeting strict guidelines, diabetic shoes must be prescribed by a physician and fit by a qualified individual, such as a certified pedorthist. The shoes must also be equipped with a

million, or more than one in every four U.S. residents over age 65, is diabetic¹. While most of these people would qualify for Medicare reimbursement for diabetic footwear, less than 15 percent are actually receiving them. These patients could benefit greatly from the protection diabetic shoes and inserts provide against the more serious foot health complications associated with diabetes, such as foot deformities, ulcerations and amputations.

The CDC recently released a study showing that the rate of diabetic amputations has fallen by more than half since the mid-1990s². Since 1993 Medicare has provided partial reimbursement for prescription diabetic shoes and inserts. Medical experts agree that many diabetic amputations can be prevented by using diabetic footwear as an integral part of a comprehensive foot care program.

But diabetic footwear isn't just about Medicare. Today's consumer is willing to pay cash for wellness, especially when it comes with the added benefit of style. It can also open the door to carrying other related profitable cash product lines such as diabetic socks, slippers, sandals or compression wear. [26]



Fig 2.13 Stylish diabetic shoe available in market

2.8.2 PRODUCT DETAILS:

Considering the various requirements of medical industry, the company offer DiabeticShoesandSandals. These shoes and sandals are specially designed to sooth variegated foot ailments related to diabetes. Our shoes and sandals are reckoned for their softness, comfort and durability. Further, these can be custom made as per the specifications provided by the clients. [27]

41



Fig 2.14 Diabetic shoe

2.9 STAPHYLOCOCCUS AUREUS:

2.9.1 INTRODUCTION:

Staphylococcus aureus, often referred to simply as “staph”, are bacteria commonly carried on the skin or in the nose of healthy people. Approximately 25% to 30% of the population is colonized(when bacteria are present but not causing an infection)in the nose with staph bacteria. Sometimes, staph can cause an infection. Staphylococcus bacteria are one of the most common causes of skin infections inunited states. Most of these skin infections are minor (such as pimples and boils) and can be treated without antibiotics (also known as antimicrobials or antibacterials). However, staphylococcus bacteria also can cause serious infections(such as surgical wound infections, blood stream infections, and pneumonia).

Some staphylococcus bacteria are resistant to antibiotics by 25% to 35% of the population is colonized with staphylococcus aureus.Staphylococcus infections occur most frequently among persons in hospitals and health care facilities (such as

42

nursing homes and dialysis centres)who have weakened immune systems.These health care-associated staph infections include surgical wound infections,urinary tract infections,blood stream infections and pneumonia. [32]



Fig 2.15 Staphylococcus aureus

Staphylococcus bacteria can also cause illness in persons outside of hospitals and health care facilities. Staphylococcus infections in the community are usually manifested as skin infections, such as pimples and boils, and occur in otherwise healthy people.

Staphylococcus bacteria are one of the most common causes of skin infections in united states and are a common cause of pneumonia, surgical wound infections and blood stream infections. Data from a prospective study in 2003, suggest that 12% of clinical infections are community-associated, but this varies by geographic region and population. [33]

43

2.9.2 APPEARANCE OF STAPHYLOCOCCUS INFECTION:

Staphylococcus bacteria , can cause skin infections that may look like a pimple or boil and can be read, swollen, painful or have pus or other drainage. More serious infections may cause pneumonia, blood stream infections or surgical wound infections.

Factors that have been associated with the spread of skin infections include: close skin-to-skin contact, openings in the skin such as cuts or abrasion, contaminated items and surfaces, crowded living conditions and poor hygiene. [32]

1. Agent:Staphylococcus aureusa Gram positive bacterium. Most staphylococcus.aureusis divided into 2 groups: methicillin-resistant (MRSA) and methicillin-sensitive (MSSA).

2. Identification:

a. The most common staphylococcal infections include impetigo, boils, carbuncles, abscesses, and infected wounds. Methicillin-resistant Staphylococcus aureus(MRSA) is the most common cause of community acquired bacterial skin infections in the United States.

In rare cases, community acquired staphylococcus aureusmay result in bacteremia, meningitis, pneumonia, or necrotizing fasciitis.

Outbreaks of staphylococcus aureus skin infections are often found in close crowded living conditions such as correctional facilities, homeless shelters or in the military.

44

b. Differential Diagnosis: Miliaria (heat rash), diaper dermatitis, chemical conjunctivitis, and cellulitis or abscesses due to other pyogenic organisms (primarily group A streptococcus).

c. Diagnosis: Culture of organism from involved site. PCR may be used in some circumstances to identify MRSA (not MSSA)

3. Incubation: Variable and indefinite; commonly 2 to 10 days. However, people may be colonized for months-years before an infection occurs.

4. Reservoir: Human; some farm and domestic animals.

5. Source: Nares, perineum, and any purulent lesion. Thirty to forty percent of the general population carries MSSA in their anterior nares and moist body areas; 1-3% carries MRSA in these same areas.

6. Transmission: Usually by contaminated hands, contact with infected or colonized site, or fomites; airborne droplet spread is rare. Staphylococcus aureus is not commonly found in water, especially water that is adequately chlorinated.

7. Communicability: As long as viable organisms exist in lesion or the carrier state persists, the person may continue to autoinfect themselves or others. Staphylococcus aureus may survive in dry environments for weeks.

8. Specific Treatment:

Case: Therapy should consider the drug sensitivity pattern of the organism. Resistance to methicillin is a marker for resistance to all β -lactam antibiotics such as penicillin or the cephalosporins. Many skin infections due to staphylococcus aureus will clear-up with good skin care and drainage of pus (if necessary) and may not need antibiotics for treatment.

45

should be performed before and after changing bandages. Soap and water or an alcohol based hand rub (at least 62% alcohol) will effectively disinfect hands.

According to the California Food Code, if the patient is a food handler and has a rash, skin lesion or open/drainage wound on their hand(s) or the exposed part(s) of their arm(s), they are required to wear an impermeable cover over the condition. If the lesion is on another part of their body, they must wear a dry, durable, tight-fitting bandage. Otherwise they must report their condition to their employer. All employees with any cuts, sores, or rashes must wear gloves when contacting food and food contact surfaces.

Patients do not need to be on antibiotics or complete an antibiotic course before returning to their usual activities. [33]

2.9.5 CONTACTS:

Contacts are persons in close contact with patient with any staphylococcal disease

1. Emphasize hand hygiene, especially before and after handling any soiled bandages.

2. Encourage contacts to check skin for any new lesions or infections. Contacts with new infections should be encouraged to see their healthcare provider for diagnosis and treatment. [33]

2.9.6 CARRIERS:

It is rarely worthwhile to search for nasal carriers or perform environmental sampling. [33]

47

Carriers: There is no reason to treat carriers in community settings unless there are repeated autoinfections. Consider decolonization of patients who will undergo cardiac, orthopedic or neurosurgery procedures with implants. Decolonization treatment consists of topical antibiotics to the nares and anti-staphylococcal soap to the body for at least 5 days. Consult with ACDC if considering recommending decolonization.

8. **Immunity:** None.

2.9.3 REPORTING PROCEDURES :

Outbreaks: all outbreaks of Staphylococcus aureus (MRSA or MSSA) in the community are reportable within one working day of identification. California Code of Regulations, Section 2500

Severe community acquired Staphylococcus aureus infections are also reportable. A case is defined as a patient who dies or is admitted to an intensive care unit due to infection with staphylococcus aureus and who has not had surgery or dialysis or been hospitalized, or resided in a long-term care facility in the past year, and did not have an indwelling catheter or percutaneous medical device at the time of culture. Cases are reportable within seven working days of identification. California Code of Regulations, Section 2500. ACDC investigates severe cases of community acquired staphylococcus aureus. [33]

2.9.4 PRECAUTIONS:

Appropriate hand hygiene should be emphasized. Skin lesions should be covered with a clean dry bandage and patients should be taught how to dispose of soiled bandages appropriately. Patients may return to work, school, or usual activities if they can maintain a clean, dry bandage over any open skin lesion. Hand hygiene

46

2.9.7 PREVENTION-EDUCATION

1. Stress importance of personal hygiene. Emphasize hand hygiene, regular bathing or showers, and changing clothes.

2. Stress importance that cases/carriers or contacts do not share personal skin care articles such as soap, razors, towels, etc.

3. Emphasize proper disposal of bandages and disinfection of fomites.

Storage: Room temperature. [33]

2.10 KLEBSIELLA:

2.10.1 INTRODUCTION:

Klebsiella pneumoniae is a gram negative, non-motile facultative anaerobe belonging to the Enterobacteriaceae family. It consists of straight rods 1 to 2 micrometres in length with a thick, surrounding capsule when cultured, this species produces a distinctive yeasty odour and bacterial colonies have a viscous/ mucoid appearance.

Klebsiella pneumoniae can cause serious infections that may often be fatal. Drug resistant pneumonia, chronic nasal infections, urinary tract infections, bronchitis and even gangrene are some of the infections these common bacteria can cause in susceptible people. Infections can spread rapidly and are most often acquired in the hospital while being treated for other illnesses or surgical procedure. The main sources of klebsiella infections are the hands of hospital staff and the gastrointestinal tract of patients. [34]

48

2.10.2 AVAILABILITY OF KLEBSIELLA:

Klebsiella also occurs naturally in the soil. These strains of klebsiella are beneficial because they carry out nitrogen fixation, a process critical to the completion

Of the nitrogen cycle, Klebsiella pneumoniae carry out nitrogen fixation as free living soil organisms. The majority of human infections are caused by klebsiella pneumoniae and klebsiella oxytoca. [34]

2.10.3 PREVENTION/SOLUTION:

Klebsiella is mainly a nosocomial infection, which are hospital acquired infections. If an infection appears 48hrs or more after hospital admission or within 30days of discharge, it is considered to be nosocomial. Careful hand washing by medical staff before and after treating each patient is an effective way to avoid nosocomial infections. [35]

2.10.4 RISK FACTORS:

Contact with fecal matter is a significant source of infection. Hospitalized patients with invasive devices such as feeding tubes, indwelling catheters, central venous catheters and who are generally in poor health are at particular risk for contracting a klebsiella infection. Those with alcoholism, lung disease and diabetes are also at risk. A klebsiella infection may often need two powerful antibiotics as the bacteria are resistant to penicillin and many others due to excessive use in hospitals of broad spectrum antibiotics. [35]

49

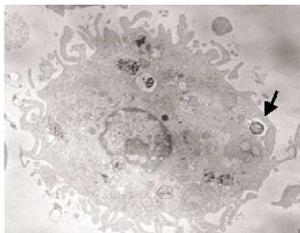


Fig 2.16 Klebsiella



Fig 2.17 Agar plate streaked with klebsiella pneumoniae

51

2.10.5 CHARACTERISTICS:

Klebsiella spp. is Gram-negative, nonmotile, usually encapsulated rod-shaped bacteria, belonging to the family Enterobacteriaceae. These bacteria produce lysine decarboxylase but not ornithine decarboxylase and are generally positive in the Voges-Proskauer test. Members of the Enterobacteriaceae family are generally facultatively anaerobic, and range from 0.3 to 1.0 mm in width and 0.6 to 6.0 mm in length. Klebsiella spp. often occur in mucoid colonies. The genus consists of 77 capsular antigens (K antigens), leading to different serogroups. [36]

2.10.6 PATHOGENICITY/TOXICITY:

Klebsiella spp. have been identified as important common pathogens for nosocomial pneumonia (7 to 14% of all cases), septicaemia (4 to 15%), urinary tract infection (K. rhinoscleromatis causes rhinoscleroma (K. variicola – humans and plants. [36]

2.10.7 MODE OF TRANSMISSION:

Klebsiella spp. can be transmitted through skin contact with environmentally contaminated surfaces and/or objects; examples include Loofah sponges, medical equipment, and blood products. Fecal transmission has also been suggested for some cases of bacteremia caused by Klebsiella spp. K. rhinoscleromatis can be transmitted from person-to-person via airborne secretions; however, prolonged contact with infected individuals is required for infection.

K. granulomatis are sexually transmitted. They may also be vertically transmitted (from mother to child) or by accidental inoculation. Transmission rates between partners are low (<50%) compared to other sexually transmitted diseases. [36]

50

2.11 PSEUDOMONAS:

2.11.1 INTRODUCTION:

It is a gram-negative, aerobic coccobacillus bacterium with unipolar motility. An opportunistic human pathogen and also an opportunistic pathogen of plants. P. aeruginosa secretes a variety of pigments, including pyocyanin (blue-green), pyoverdine (yellow-green and fluorescent) and pyorubin (red-brown). [39]

Pseudomonas aeruginosa is often preliminarily identified by its pearlescent appearance and grape like or tortilla like odour in vitro. Definitive clinical identification pseudomonas aeruginosa often includes identifying the production of both pyocyanin and fluorescein as well as its ability to grow at 42°C. Pseudomonas aeruginosa is capable of growth in diesel and jet fuel where it is known as a hydrocarbon using microorganism causing microbial corrosion. It creates dark gellish mats sometimes improperly called as "algae" because of their appearance. [39]

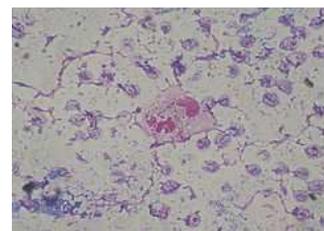


Fig 2.18 Phagocytosis of P. aeruginosa by neutrophil in patient with bloodstream infection (Gram stain)

52

2.11.2 AVAILABILITY OF PSEUDOMONAS:

Pseudomonas aeruginosa is a common bacterium that can cause disease in animals, including humans. It is found in soil, water, skin flora and most man-made environments throughout the world. It uses a wide range of organic material for food, and animals, the versatility enables the organism to infect damaged tissues or those with reduced immunity. The symptoms of such infections are generalised inflammation and sepsis. If such colonisation occurs in critical body organs such as the lungs, the urinary tract, and kidney the result can be fatal. Because it thrives on most surfaces, this bacterium is also found on and in medical equipment. [40]

2.11.3 CHARACTERISTICS:

The genus *Pseudomonas* of the *Pseudomonadaceae* family is motile gram-negative aerobic bacteria, 2 – 4 µm long plump-shaped rods, with polar flagella which have an important role in pathogenicity. They are non-spore forming and can produce pigments, such as pyocyanine (green-blue) and pyorubrin (yellow-green) fluorescence. *P. aeruginosa* can produce a large variety of extracellular toxins, including exotoxin A and enterotoxins. Other substances such as hydrocyanic acid, proteolytic enzymes, toxic surface slime, and haemolytic substances may also contribute to the pathogenicity of this species. Toxins combined with harmful substances are determinant factors in the high virulence of *P. aeruginosa* in a variety of different hosts. [40,41,42,43]

2.11.4 MODE OF TRANSMISSION:

P. aeruginosa have been found to survive within droplet nuclei and can remain in aerosols for long periods of time, thus there is evidence of potential airborne transmission with contaminated water is also a major route, but since the oral

of unburned skin at wound margins and green pigment in subcutaneous fat. *P. aeruginosa* is also associated with swimmer's ear (otitis externa). Other *Pseudomonas* species are also opportunistic; however, cases of infection are rare. [44]

2.11.6 EPIDEMIOLOGY:

Worldwide – often a problem in hospitals as it can be found on equipment, increasing the risk of nosocomial infections. 30–40% of those with cystic fibrosis will acquire chronic pseudomonal infection. *P. aeruginosa* infections account for 20% of pneumonia and 16% of urinary tract infections. Prevalence in the community is less than in the hospital, and cases of severe community-acquired infection are rare. [43,33]

infectious dose is thought to be very high, routes that pose the greatest health risk are skin exposure (for example, in contaminated hot tub water) and lung exposure from inhaling aerosols discharged from infected respiratory tracts. The bacterial can often enter the body through injuries and wounds. The use of contaminated mechanical respiratory ventilators in hospital settings is also a common source of nosocomial infections. [44]

2.11.5 PATHOGENICITY/TOXICITY:

As opportunistic pathogens, *Pseudomonas* spp. often invades the host tissue and cause infection and bacteremia in immunocompromised hosts (e.g., HIV/AIDS, cystic fibrosis, bronchiectasis, and severe chronic obstructive pulmonary disease, burns, malignancy, or diabetes mellitus). The common site of infection is the lower respiratory tract, and severity ranges from colonization without immunological response to severe necrotizing bronchopneumonia; such severe infection in patients with cystic fibrosis is almost impossible to eradicate once established in the airways. Pseudomonal pneumonia often develops from oro-pharyngeal contamination or secondary bacteremia, and is also a common cause of nosocomial ventilator-related pneumonia in intensive care settings. Infections also include endocarditis, osteomyelitis, urinary tract infections, gastrointestinal infections, meningitis, and, commonly, septicemia. *P. aeruginosa* is the most common agent associated with infection and inflammation during contact lens wear. The bacteria colonize on lenses and produce proteases to kill or invade corneal cells, an infection that can lead to scarring and vision loss. The species is also the most virulent with a mortality rate of 30%, which can be higher depending on predisposing conditions. *P. aeruginosa* can also readily colonize on open burn wounds, causing infections, abscesses, and sepsis, with edema and/or discoloration

53

54

CHAPTER 3

MATERIAL AND METHODS

3.1 WEB PREPARATION:

Every single lap is made by making use of the carding machine, weighing the fibre to 40gms. The weighed fibre is fed into the carding machine as required and finally a lap is formed. Likewise the necessary laps are developed.

3.2 NEEDLE PUNCHING:

The bamboo lap is fed into the needle punching machine. The needles penetrate into the lap and a punching of lap occurs. Finally the needle punched non-woven material is produced.

3.3 CHITOSAN SOLUTION PREPARATION:

The solution is prepared based upon the material weight and also by varying the weight of the chitosan. Here citric acid used to dissolve the chitosan powder.

In generally the material is weighed. According to the M:L ratio 1:20, the water, citric acid and the chitosan is taken as per the weight of the non-woven material. In another process, material weight is kept constant and the amount of chitosan powder is varied.

Take a beaker, fill the required amount of water. Add the citric acid and allow it to dissolve in it. Then add the chitosan powder. Continuous stirring should be given to the solution, so that the chitosan can dissolve easily and hence the chitosan solution is prepared.

55

56

3.4 TRAY TECHNIQUE:

Cut needle punched material to the required size and place in a plastic tray. Now take the solution and spread it evenly on the material. The material is left to dry at the room temperature for 48hrs.

3.5 TESTING:

3.5.1 ANTIBACTERIAL TEST:

AATCC 147 parallel streak test method:-

To detect bacteriostatic activity on tensile materials.

- A loopful of inoculum is transferred to the surface of sterile agar plate in 5 streaks.
- Rectangular cut sample is placed transversely across streaks to ensure intimate contact with agar surface.
- Incubation period of 24-48 hours at body temperature.
- A clear area of interrupted growth underneath and along the sides of the test material indicate antibacterial activity.

The parallel streak method has filled a need for a relatively quick and easily executed qualitative method to determine antibacterial activity of diffusible antimicrobial agents on treated textile materials.

AATCC method 100, antibacterial test on textile materials, is a quantitative procedure which is adequately sensitive but cumbersome time and screening tests. Therefore when the intent is to demonstrate bacteriostatic activity by the diffusion of the antibacterial agent through agar, method 147 fulfills this need. In the parallel streak method, the agar surface is inoculated making it easier to

57

distinguish between the test organism and contaminant organism which may be present on the unsterilized specimen. The parallel streak method has proven effective over a number of years of use in providing evidence of antibacterial activity against positive and negative bacteria.

3.5.2 WOUND PATHOGEN TEST:

AGAR DIFFUSION PLATE TEST:

ENISO 20645 is essentially a qualitative test method for determining the effect of antibacterial treatments applied to woven, knitted and other flat textiles. A minimum diffusion of the antibacterial into the test agar is necessary with the procedure. Standard conditions specify a contact time period of 18 to 24 hours using *Pseudomonas* and *Klebsiella*.

The antibacterial activity of the finished fabric was tested according to EN ISO 20645 against *Klebsiella* sp., and *Pseudomonas* sp.,. Nutrient agar plates were prepared by pouring 15 ml of media into sterile Petri dishes. The plates were allowed to solidify for 5 minutes and 0.1% inoculum was swabbed uniformly and allowed to dry for 5 minutes. The finished fabric with the diameter of 2.0 ± 0.1 cm was placed on the surface of medium and the plates were kept for incubation at 37°C for 24 hours. At the end of incubation, the zone of inhibition formed around the fabric was measured in millimeters and recorded.

3.5.3 WATER ABSORPTION AND WATER DESORPTION TEST:

The sample is cut into 50*50 sq.mm. Initial weight is noted. The sample is then soaked in water with the help of a tray for about 6 hours. Then the sample is taken out and left on a blotted paper. The water is absorbed and later the sample is allowed for weighing as final weight.

58

The sample is cut into a size of 50*50 sq.mm and weighed. The weight is noted as initial weight. The sample is soaked in water in a tray for about 6 hours. Later the sample is taken out and kept still for 16 hours. The sample is allowed for weighing. The final weight is noted.

Water desorption/ water absorption = (Final weight – Initial weight)/ Final weight

3.5.4 WET TENSILE TEST:

The required sample is cut into a dumbbell shape. Both the ends are hooked and are allowed under load. At an optimum point the material breaks. That point is noted. It is applied in a formula,

Tensile strength = load / (Width * thickness of the material)

3.5.5 FLEXING INDEX:

The samples are cut into strips of 10mm each. One end of the sample is fixed, and the other is allowed to get fixed to a swing. The pendulum is allowed to swing from one point to another, likewise at one point of time the material breaks. That point is noted in the instrument. The values are noted for about 30 cycles. The log value is found by comparing the norms. The values are noted.

CHAPTER 4

RESULT AND DISCUSSION

4.1 ANTIBACTERIAL TEST:

4.1.1 PROCEDURE:

AATCC 147 parallel streak test method:-

To detect bacteriostatic activity on tensile materials.

- A loopful of inoculum is transferred to the surface of sterile agar plate in 5 streaks.
- Rectangular cut sample is placed transversely across streaks to ensure intimate contact with agar surface.
- Incubation period of 24-48 hours at body temperature.
- A clear area of interrupted growth underneath and along the sides of the test material indicate antibacterial activity.

The parallel streak method has filled a need for a relatively quick and easily executed qualitative method to determine antibacterial activity of diffusible antimicrobial agents on treated textile materials.

AATCC method 100, antibacterial test on textile materials, is a quantitative procedure which is adequately sensitive but cumbersome time and screening tests. Therefore when the intent is to demonstrate bacteriostatic activity by the diffusion of the antibacterial agent through agar, method 147 fulfills this need. In

59

60

the parallel streak method, the agar surface is inoculated making it easier to distinguish between the test organism and contaminant organism which may be present on the unsterilized specimen. The parallel streak method has proven effective over a number of years of use in providing evidence of antibacterial activity against positive and negative bacteria.

4.1.2 INTERPRETATION:

A clear area of interrupted growth underneath and along the sides of the test material indicate ANTI-BACTERIAL ACTIVITY. The table 4.1, figure 4.1 and figure 4.2 shows the antibacterial activity result, graphical representation of the result and sem image of the test respectively.

Table 4.1 INTERPRETATION OF ANTIBACTERIAL TEST

SAMPLE	ANTI-BACTERIAL ACTIVITY AGAINST STAPHYLOCOCCUS AUREUS(zone of inhibition-mm)
Needle punched Bamboo non-woven finished with chitosan	45

4.1.3 GRAPHICAL REPRESENTATION:

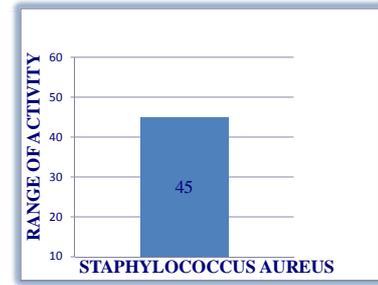


Fig 4.1 Grapical representation of antibacterial activity

4.1.4 SEM IMAGE OF ANTI-BACTERIAL TEST ON THE SAMPLE:



Fig 4.2 Sem image of anti bacterial test carried on the sample

4.1.5 VARIABLES:

4.1.5.1 INTERPRETATION:

A clear area of interrupted growth underneath and along the sides of the test material indicate ANTI-BACTERIAL ACTIVITY. The table 4.2, figure 4.3, figure 4.4 shows the antibacterial activity result of three variables, graphical representation of those results and sem image of the tests respectively.

Table 4.2 Interpretation of anti-bacterial activity for the variables

S.NO	SAMPLES	ANTIBACTERIAL ACTIVITY AGAINST STAPHYLOCOCCUS AUREUS(ZONE OF INHIBITION-mm)
1	Bamboo web finished with chitosan -1	40
2	Bamboo web finished with chitosan -2	42
3	Bamboo web finished with chitosan -3	43

4.1.5.2 GRAPHICAL REPRESENTATION:

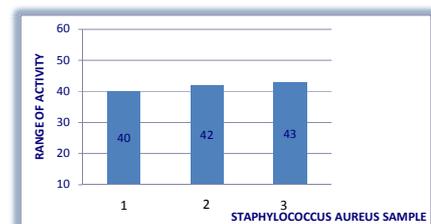


Fig 4.3

Grapical representation for anti-bacterial test for variables

4.1.5.3 SEM IMAGE OF ANTIBACTERIAL TEST CARRIED OUT IN VARIABLES:



Fig 4.4 Sem image of anti-bacterial activity for variables

4.2 WOUND PATHOGEN TEST:

4.2.1 PROCEDURE:

AGAR DIFFUSION PLATE TEST:

ENISO 20645 is essentially qualitative test method for determining the effect of antibacterial treatments applied to woven, knitted and other flat textiles. A minimum diffusion of the antibacterial into the test agar is necessary with the procedure. Standard conditions specify a contact time period of 18 to 24 hours using pseudomonas and klebsiella.

The antibacterial activity of the finished fabric was tested according to EN ISO 20645 against Klebsiella sp., and Pseudomonas sp., Nutrient agar plates were prepared by pouring 15 ml of media into sterile Petri dishes. The plates were allowed to solidify for 5 minutes and 0.1% inoculum was swabbed uniformly and allowed to dry for 5 minutes. The finished fabric with the diameter of 2.0 ± 0.1 cm was placed on the surface of medium and the plates were kept for incubation at 37°C for 24 hours. At the end of incubation, the zone of inhibition formed around the fabric was measured in millimeters and recorded.

4.2.2 INTERPRETATION:

A clear area of interrupted growth underneath and along the sides of the test material indicate GOOD activity towards WOUND PATHOGENS. The table 4.3, figure 4.5, and figure 4.6 shows the result of wound pathogen test, graphical representation of the result, and sem image of the test respectively.

Table 4.3 Interpretation of wound pathogen test

S.NO	SAMPLE	ORGANISMS	
		KLEBSIELLA sp.,	PSEUDOMONAS sp.,
1	BAMBOO WEB FINISHED WITH CHITOSAN	37	36

4.2.3 GRAPHICAL REPRESENTATION:

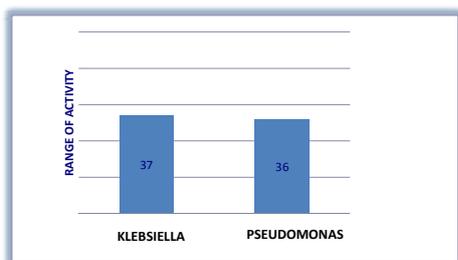


Fig 4.5 Graphical representation for wound pathogen test

4.2.4 SEM IMAGE OF WOUND PATHOGEN TEST:

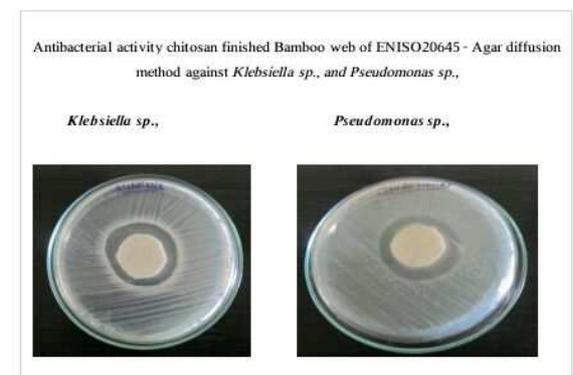


Fig 4.6 Sem image of wound pathogen test carried on the sample

4.3 MECHANICAL TEST:

4.3.1 WET TENSILE STRENGTH TEST:

4.3.1.1 PROCEDURE:

The required sample is cut into a dumbbell shape. Both the ends are hooked and are allowed under load. At an optimum point the material breaks. That point is noted. It is applied in a formula,

$$\text{Tensile strength} = \text{load} / (\text{Width} * \text{thickness of the material})$$

The figure 4.7 shows the graphical representation of the wet tensile strength result for two direction of the fabric.

4.3.1.2 REPORT:

Mean tensile strength (direction 1) - 0.12 Mps

Mean tensile strength (direction 2) - 0.64Mps

Average thickness of the specimen is 2.2 mm

4.3.1.3 GRAPHICAL REPRESENTATION:

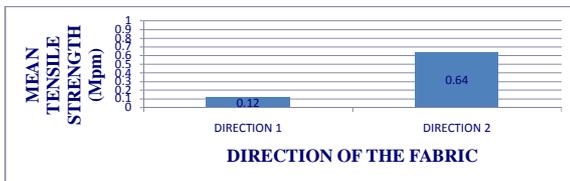


Fig 4.7 Graphical representation for wet tensile strength

4.3.2 WATER ABSORPTION AND DESORPTION TEST:

4.3.2.1 PROCEDURE:

The sample is cut into 50*50 sq.mm. Initial weight is noted. The sample is then soaked in water with the help of a tray for about 6 hours. Then the sample is taken out and left on a blotted paper. The water is absorbed and later the sample is allowed for weighing as final weight.

The sample is cut into a size of 50*50 sq.mm are weighted. The weight is noted as initial weight. The sample is soaked in water in a tray for about 6 hours. Later the sample is taken out and kept still for 16 hours. The sample is allowed of weighing. The final weight is noted.

$$\text{Water desorption/ water absorption} = (\text{Final weight} - \text{Initial weight}) / \text{Final weight}$$

The figure 4.9 and figure 4.8 shows the water absorption and desorption result respectively.

4.3.2.2 REPORT:

Water absorption - 493.4%

Water desorption - 85.2%

4.3.2.3 GRAPHICAL REPRESENTATION OF WATER ABSORPTION:

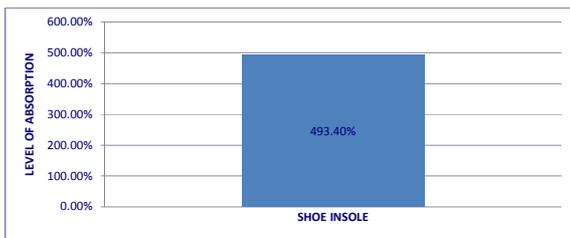


Fig 4.8 GRAPHICAL REPRESENTATION FOR WATER ABSORPTION

4.3.3 FLEXING INDEX:

4.3.3.1 PROCEDURE:

The samples are cut into strips of 10mm each. One end of the sample is fixed, and other is allowed to get fixed to a swing. The pendulum is allowed to swing from one point to another, likewise at one point of time the material breaks. That point is noted in the instrument. The values are noted for about 30 cycles. The log value is found by comparing the norms. The values are noted.

4.3.3.2 REPORT:

Flexing index (Direction 1) - 2.8

Flexing index (Direction 2) - 1.3

4.3.2.4 GRAPHICAL REPRESENTATION OF WATER DESORPTION:

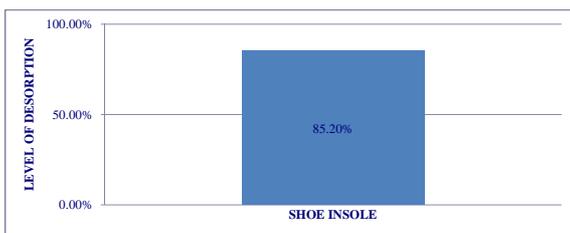


Fig 4.9 GRAPHICAL REPRESENTATION OF WATER DESORPTION

CONCLUSION

The raw materials of our project itself are of great importance because both the materials are natural and have good anti-bacterial activity and hence the main objective of our project is achieved. The product was tested for antibacterial and wound pathogen test. Both the test gave good activity towards bacteria and organisms.

Therefore it is proven that our diabetic shoe insole will heal the wound of foot ulcer. Even by reducing chitosan to some extent and not much, it is possible to heal the foot ulcer of the diabetic patients.

In recent trends people are looking up for easy-go. This product all stands up in this way. This all adds up as **use and throw** and also **wound healing product**.

Since the diabetic patients are at high for subsequence ulceration, the use of special footwear to protect the feet is highly recommended. When wound prevails in diabetic patients, the time to heal the wound is long and hence to make it in a short period of time and good healing activity; we have proudly introduced our product as shoe insole for diabetic patients using bamboo fibre and chitosan powder.

Hence, the shoe insole proves the following result.

- The given fabric sample have **GOOD** antibacterial activity against the test organism.
- The given samples have **GOOD** wound healing activity against the test organism.

REFERENCE:

1. trj.sagepub.com/
2. bambrotex.com
3. bambroofabricstore.com
4. en.wikipedia.org/wiki/Textile-bleaching
5. philexport.ph/ads/bamboo/guide.pdf
6. isamm.org/eco-friendly-fabric.html
7. organicclothing.blogs.com/my_weblog/2001/09/bamboo-facts-be.html
8. greenyarn.com/products.html
9. fibre2fashion.com
10. ezinearticles.com/?spun-bamboo
11. etsy.com/listing/28157796/bamboo-shoes-size-10
12. mygreenmattress.com
13. bamboclothes.com/
14. www.swicofil.com
15. www.dermnetnz.org
16. www.diabetes.webmd.com
17. www.oculosis.com
18. www.maca.nsw.goc.aw
19. http://www.gseworld.com/applications/landfill-liners.html
20. http://turnkey.taiwantrade.com.tw/en/Content.aspx?ID=11
21. www.goldleaf2011.en.made-in-china.com
22. Diabetic Socks - ManagingDiabetes.co.uk
23. Feldman and Davis 'Sock wear Recommendations for People with Diabetes' - Diabetes Spectrum. - 14 (2): 59
24. http://ezinearticles.com
25. http://EzineArticles.com/2265879
26. Foot Complications, from the American Diabetes Association; first published no later than November 4, 2009 (as per archive.org); retrieved September 6, 2011.
27. 'Diabetic Foot Care at ePodiatry' published 2003, retrieved September 6 2011.
28. http://www.orthoticshop.com/images/D/AetrexBlowUp.jpg
29. http://homecaremag.com/senior-care-products/diabetic-footwear?page=2
30. http://trade.indiamart.com/details.mp?offer=2046699797
31. http://homecaremag.com/senior-care-products/diabetic-footwear?page=2
32. Proctor, R.A. et al. (2006) Small colony variants 'a pathogenic form of bacteria that facilitates persistent and recurrent infections'. Nat. Rev. Microbiol. 4, 295-305
33. Chatterjee, I. et al. (2007) 'Enhanced post-stationary-phase survival of acclinal thymidine-dependent small-colony variant of Staphylococcus aureus results from lack of a functional tricarboxylic acid cycle. J. Bacteriol' 189, 2936-2940
34. Rosenblueth, M., Martinez, L., Silva, J., & Martinez-Romero, E. (2004). Klebsiellavariicola, a novel species with clinical and plant-associated isolates. Systematic and Applied Microbiology, 27(1), 27-35.
35. 'Emergence of a new antibiotic resistance mechanism in India, Pakistan, and the UK: a molecular, biological, and epidemiological study. The Lancet Infectious Diseases' 10(9), 597-602. doi:10.1016/S1473-3099(10)70143-2
36. Disinfection and Sterilization. (1993). Laboratory Biosafety Manual 8. (2nd ed., pp. 60-70). Geneva: WHO.

37. Mason, C. A., & Hamer, G. (1987). Survival and activity of *Klebsiella pneumoniae* at super-optimal temperatures. *Bioprocess and Biosystems Engineering*, 2(3), 121-127.
38. Joslyn, L. J. (2000). Sterilization by Heat. In S. S. Block (Ed.), *Disinfection, Sterilization, and Preservation* (5th ed., pp. 695-728). Philadelphia.
39. [H:/project/pseudomonas/Pseudomonas%20aeruginosa.htm](http://project.pseudomonas/Pseudomonas%20aeruginosa.htm)
40. Willcox, M. D. (2007). *Pseudomonas aeruginosa* infection and inflammation during contact lens wear: a review. 'Optometry and Vision Science' Official Publication of the American Academy of Optometry, 84(4), 273-278. doi:10.1097/OPX.0b013e3180439c3e
41. Dasgupta, N., Arora, S. K., & Ramphal, R. (2000) 'fleN, a gene that regulates flagellar number in *Pseudomonas aeruginosa*'. *Journal of Bacteriology*, 182(2), 357-364.
42. Kayser, F. H., Bienz, K. A., Eckert, J., & Zingemagel, R. M. (Eds.). (2001). 'Medical Microbiology' (10th ed.). Stuttgart, Germany.
43. Nadeem, S. G., Qasmi, S. A., Afaq, F., Saleem, M., & Hakim, S. T. (2009). Comparison of the in vitro susceptibility of Clinical isolates of *Pseudomonas aeruginosa* in a local hospital setting in Karachi, Pakistan. *British Journal of Medical Practitioners*, 2(4), 35-39.
44. Ishihara, S., Takino, M., Okada, Y., & Mimura, K. (1995). Septic shock due to *Pseudomonas aeruginosa* in a previously healthy woman. *Intensive Care Medicine*, 21(3), 226-228.