CHAPTER 2

REVIEW OF LITERATURE

2.1 MEDICAL TEXTILE

Textile is ever-present and are used all through the world for various purposes every day. The coverage of textile technology and medical sciences has resulted into a innovative field called “Medical textiles”. For manufacturing medical textile materials, a number of natural and synthetic fibres are being used based on their end uses. Among the natural fibres, bamboo is one of the most extensively used biomaterial for research specially in the field of medical textile researches. Medical textile is a innovative with fastest rate of growing field in the field textile technology with tremendous market potential (Czajka 2005, Hofer et al. 2003). Medical textiles include hospital usages such as wound dressings, gauzes, bandages, surgical masks, fibrous implants, sutures, drug carrier, artificial organs, hospital linens, clothing used for rehabilitation and so on. The base materials such as cotton, silk, bamboo and wool are the natural fibre groups, which are biodegradable and biocompatible in nature are used in medical applications across countries for wound dressing (Cao & Wang 2009, Sherif & Roedel 2011).

In this modern world every consumer demands for safe eco-friendly medical textile products which has been growing day by day. Highly trended at present is the usage of natural polymers to dress the wounds, which are biodegradable in nature.
Table 2.1 Usage of textile based products in medical applications

(Source: Struszczyk & Olejnik 2012)

<table>
<thead>
<tr>
<th>Group of Technologies</th>
<th>Particular Technologies</th>
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<tbody>
<tr>
<td>1. Wound Dressing</td>
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<tr>
<td>1.1</td>
<td>Auxiliary Materials for wound dressings – secondary wound dressings</td>
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<tr>
<td>1.2</td>
<td>Primary wound dressings (non – occlusive)</td>
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<tr>
<td>1.2</td>
<td>Primary wound dressings (occlusive)</td>
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<tr>
<td>1.3.1</td>
<td>Resorbable wound dressings</td>
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<tr>
<td>1.3.2</td>
<td>Advanced wound dressings incl. wound dressing designed from genetically modified raw – sources containing bioactive substances and / or designed using bio technologies, etc.</td>
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<tr>
<td>2. Auxiliary textile medical devices</td>
<td></td>
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<td>3. Fibrous Implants</td>
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<tr>
<td>3.1</td>
<td>Implants for hernia treatments</td>
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<tr>
<td>3.2</td>
<td>Implants for vaginal reconstructions or urinary incontinence treatments</td>
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<tr>
<td>3.3</td>
<td>Implants for the reconstruction of skull and facial bones</td>
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<tr>
<td>3.4</td>
<td>Implants for vascular reconstructions</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Components of endo vascular prostheses for less – invasive surgical procedures</td>
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<tr>
<td>4. Sutures</td>
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<tr>
<td>4.1</td>
<td>Resorbable</td>
</tr>
<tr>
<td>4.2</td>
<td>Non- Resorbable</td>
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<tr>
<td>5.</td>
<td>Fibrous scaffolds for the tissue reconstructions</td>
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<tr>
<td>6.</td>
<td>Advanced fibrous carriers for medicines</td>
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<tr>
<td>7.</td>
<td>Artificial organs or fibrous components for artificial organ design</td>
</tr>
<tr>
<td>5,6,7</td>
<td>Fibrous borderline products (medical devices containing bio active substances or incorporating, as an integral part, ancillary medicinal substances, ancillary human blood derivative, drug delivery scaffolds or carriers)</td>
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</table>
The main advantage of biodegradable polymers is that delivering biological molecules at controlled rates which results in the reduced number of repeated treatments (Determan et al. 2006, Lopac et al. 2009).

In Poland, Struszczyk & Olejnik (2012) conducted a study as shown in Table 2.1 and assessed about different forms of textile medical devices which makes clear the usage of textile based products in medical applications.

2.2 WOUND

The disruption on the natural anatomical structure results in the formation of wound (Lazarus et al. 1994 & Priyanka Agrawal et al. 2014) and depending upon their tissue loss wounds can be classified into two types i.e., wounds without tissue loss (eg, in surgery) and wounds with tissue loss (which includes burn wounds, wounds caused by trauma and diabetic ulcers). To cover the wounds and absorb bleeding these wound dressings have been used.

The flow of wound healing includes like embryogenesis and tissue regeneration and are fundamental processes. It includes several individual but interconnected stages like homeostasis, inflammation stage, proliferation and matrix remodeling (Guo & DiPietro 2010, 2004).

Chronic wounds – the term may mean as a wound take long time to heal (more than 12 weeks and longer), since the process of healing does not proceed in the orderly set of stages (Zahedi et al. 2010). Since the chronic wounds does not follow the orderly set of stages in healing, it ultimately fail in wound closure. Healing of wound is delayed due to poor treatment, physical and biological state, nutritional status and prolonged infections. Diabetic foot ulcers and sores, venous statis, pressure ulcers and severe
physiological contaminations are generally classed as chronic wounds (Kulkarni 2012, Babaei et al. 2013).

Burn wounds can be classified (Figure 1.1 – Source: The Burn Patient, James Radin ) according to involvement of skin and deeper tissues as follows:

- First-degree burn or epithelial burns – Skin is erythematic without vesication.
- Second-degree burns - Involving epidermis and variable thickness of dermis. This is again divided into
- Second-degree superficial - where vesication and inflammation is seen in skin as only papillary dermis is involved.

(Source: The Burn Patient, E.James Radin)

Figure 2.1 Degree of Burn Wounds
• Second-degree deep - eschar formation is seen as it involves deep reticular dermis.

• Third-degree burn - Also known as full thickness burns – eschar formation is present in these burns.

2.3 WOUND HEALING PROCESS

The process of wound healing is a major problem in worldwide which results significantly increase in healthcare costs. Wound healing is a difficult and energetic process of tissue repair which involves local biochemical factors such as growth factors, cells, components of Extracellular Matrix (ECM), macrophages and neutrophils and proteases interacting with each other. The process of wound healing begins when the platelets contact a damaged blood vessel and begin to stick on to the exposed collagen.

Rovee (1991) states that the attainment of restoration in the wounded tissue to the normal or quasi-normal state found prior to wounding is termed as wound healing process which is a series of complex events. Human beings have lost the ability for restoration in the majority tissues but even some amphibians and reptiles can restore their lost tissues and parts.

The medicinal wound healing can earn in different stages such as cell migration, proliferation, differentiation and scarring (production of fibrous tissues) to re-establish a functional state. With reference to the different literatures Zahedi et al. (2010) shows the unusual stages of wound healing process hemostasis, inflammation, migration, proliferation, and maturation. The stages starts with hemostasis and inflammation which occurs soon after there is injury to the skin. The second is the fibrinogen, which is one of the major components of the skin’s connective tissues that leads to the coagulation of exudates (blood without cells and platelets), and together with
the formation of a fibrin network, produces a clot in the wound, which stops the bleeding.

As a result, both hemostasis and inflammatory stages play a vital role in the healing process of a wound. Usually it takes more than 24 hours to complete the inflammatory phase which occurs simultaneously with the hemostasis phase. In this stage, blood neutrophils and phagocytes penetrate into the wound medium and enter inside the dead cells. Next is the migratory phase, in which the new and live cells called epithelial cells shift towards the skin injury to replace the dead cells.

The proliferation stage includes complete coverage of wound by epithelium. In this stage, a new stromas commonly termed as granulating tissues are formed after about 4 days. Later microphages, fibroblasts and blood vessels move toward the wound environment and forms a single unit. The total process to the completion of this stage takes about 2 weeks. All through the growth of migration phase, a drop in the inflammatory phase of the wound is regularly observed.

The last stage in the healing process of a wound is tissue remodeling. In this stage fibroblasts covers the surface of the wound completely as a fresh layer of the skin and the evidence of the wound is not visible. This remodeling stage in the healing process of wounds is also known as maturation phase.

2.4 WOUND DRESSINGS

In medical applications, a number of wound dressing types are available. The basic purpose of wound dressing is to offer some level of absorbency and wound safety, which is commonly assured by the conventional or habitual wound dressings. The state of the wound bed and the
preferred dressing function conclude the type of dressing needed (Capasso 2000). An ideal dressing has three important properties: (1) protects the wound, (2) biocompatible and (3) provides perfect hydration (moist environment). The habitual category of textile based wound dressing such as lint, gauze and wadding have its own limitations due to their failure to preserve a moist environment for successful wound healing. On the other hand, advanced category encompasses scaffolds, films, hydrocolloids, hydrogels and alginates achieve effective wound healing by on condition that an most favorable moist microenvironment for healing (Pawar et al. 2013). But these advanced materials cannot be used in all of types wound as it is difficult to place it all parts of the human. So ultimately these habitual category of textile based wound dressings such as lint, gauze and wadding should be made a commercial and successful wound dressing material in all ranges of environment.

Wound dressings have a important role in wound management. The main goal of wound care and dressing are speedy wound closure and to leave a least or aesthetically satisfactory scar (Kurhade 2013). It was stated that wounds require distinctive combination of therapy and dressing when the skin is absent or impaired because nutritious body fluids and their essential body fluids are continuously lost through the wound (Lock & Webb 1980). The prevention of invasion by microorganisms and in homeostasis, the skin plays an vital role. Skin normally needs to be covered with a dressing without delay after it is damaged.

### 2.4.1 Properties of an Ideal Wound Dressing

The following are the important properties of an ideal wound dressing:
• Helps in decreasing infection rates.
• It provides protective barrier from environmental contaminants
• Reduces pain
• Increases healing rate and
• High exudates up-take

2.4.2 Types of Wound Dressing

Proper wound management is a combination of understanding the properties of different available wound dressings and a complete awareness of the wound healing process. Three important categories of wound dressing are biologic, synthetic and biologic-synthetic. Commonly in clinical practices Alloskin and pigskin are used as biologic dressings, but their disadvantages are such as limited supplies, high antigenicity, poor adhesiveness and risk of cross contamination. Synthetic dressings normally have a long shelf life, induce minimal inflammatory reaction and carry about no risk of pathogen transmission. Biologic-synthetic dressings are bilayered and consist of high polymer and biologic materials (Jayakumar et al. 2011).

The appropriate wound dressing material and treatments to reduce dressing frequency should be concentrate always in the plan of wound care. It is also stated that most suitable and useful tissue engineering wound dressing materials should be biocompatible, porous and provide appropriate mechanical properties (Zhao et al. 2009).

An ideal dressing material should be in a state that it should maintain a moist environment at the wound interface, allow gaseous exchange, act as a barrier to micro organisms and remove excess exudates. It is also important that it should also be nontoxic, non-allergenic, non-adherent
and easily removed without trauma. It is also should be made from a readily available biomaterial that requires minimal processing, possesses antimicrobial properties and promotes wound healing (Jayakumar et al. 2011). Figure 2.4 shows different phases of wound healing.

![Figure 2.4 Phases of wound healing](Source: Zahedi et al. 2010)

2.5 **DRUG DELIVERY SYSTEM**

The predictable method of drug delivery system such as oral administration and injection etc., has been made on repeated doses for specific period of time. The improved method of approach that is named as controlled drug delivery approach used to deliver or release drug at controlled rate over a delayed period of time through a carrier device (Hines 2012, Bhowmik et al. 2013). This is a advantageous technology in terms of maintaining the drug levels within a preferred range, minimizing the side effects of the drug through optimal use and increasing patient compliance. It is observed that the rate of wound healing efficacy is higher in this kind of
modern system. This technology has found commercial success since the 1950’s (Hines 2012).

2.6 NATURAL POLYMERIC MATERIALS USED IN WOUND HEALING

The natural origin polymer-based materials offer advantages such as the creation of new opportunities for mimicking the tissue microenvironment and it can stimulate the suitable physiological responses required for cellular rejuvenation. It seems that all these features are associated with controlled biodegradation rate and the biocompatibility of these naturally based-systems can be advantageous when compared to synthetic polymers (Silva et al. 2010). The advantages and disadvantages of each polymeric material have been detailed under Table 2.2.

Table 2.2 Pros and cons of polymers

(Source: Puppi et al. (2010))

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Polymer</td>
<td>Low toxicity, low manufacture and disposal costs, renewability, biological signalling, cell adhesion, cell responsive degradation and re-modeling</td>
<td>Low mechanical, thermal and chemical stability. Risk of immuno-rejection and disease transmission. Possible loss of biological properties during formulation.</td>
</tr>
<tr>
<td>Proteins Collagen</td>
<td>Low antigenicity and good cell binding properties</td>
<td>Low biomechanical stiffness and rapid bio degradation. Toxicity of some of the cross linking agents.</td>
</tr>
</tbody>
</table>
Table 2.2 (Continued)

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poly saccharides Chitosan</td>
<td>Hydrophilic surface promoting cell adhesion, proliferation and differentiation. Good biocompatibility and acceptable host response. Anti bacterial activity.</td>
<td>Mechanical weakness and instability. Incapacity to maintain a predefined shape. Impurities affecting material properties.</td>
</tr>
<tr>
<td>Bioresorble poly (urethane)</td>
<td>Broad range of mechanical, biological and physical properties. High elasticity.</td>
<td>Acidic degradation products in poly (Esther urethanes) causing autocatalyzed degradation.</td>
</tr>
<tr>
<td>Poly phosphazenes</td>
<td>Selective substitution of side groups used for controlling polymer degradation and enhance bio compatibility and bio activity</td>
<td>Early stage of investigation as scaffold for Tissue engineering: need further investigations on mechanical properties, in vivo behaviour, etc.</td>
</tr>
<tr>
<td>Hyaluronic acid</td>
<td>Non immunogenic properties, ease of chain size manipulation. Interactions with cell – surface receptors. Production through large – scale microbial fermentation.</td>
<td>Water solubility. Its anionic surface does not thermodynamically promote cell attachment and tissue formation.</td>
</tr>
<tr>
<td>Alginates</td>
<td>Cross linking under very mild conditions. Gel injection avoiding an open surgical procedure.</td>
<td>Mechanical weakness, difficult to sterilize and to handle. Impurities affecting material properties.</td>
</tr>
<tr>
<td>Starch based materials</td>
<td>Inexpensive, suitable for processing by different techniques and into diverse shapes. High purity, nano fibrous structure, high tensile strength and good bio compatibility</td>
<td>In vivo degradation has not yet been fully assessed. Small pore size. Early stage of investigation as scaffold for tissue engineering. It need further investigation on in vivo behaviour</td>
</tr>
<tr>
<td>Bacterial cellulose</td>
<td></td>
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</tr>
<tr>
<td>Dextran</td>
<td>Chemical similarity to GAGs. Many hydroxyl groups amenable to chemical modification suitable for designing of scaffolds with specific sites for cell recognition.</td>
<td>Shortcomings typical of hydrogels. Needs modification to enhance cell adhesion. Early stage of investigation as scaffold for tissue engineering. It need further investigation on in vivo behaviour</td>
</tr>
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In vivo
Table 2.2 (Continued)

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbial Polyesters Polyhydroxyalkanoates</td>
<td>Easy processability, broad range of mechanical and biodegradation properties</td>
<td>High cost of production compared to conventional plastics</td>
</tr>
<tr>
<td>Synthetic Polymers</td>
<td>Physical, Chemical and mechanical properties tailorable to the specific needs, thanks to the wide variety of copolymers, polymer blends and composites with other materials. Easily processable into desired shape and size. Low risks of toxicity, immunogenicity and infections.</td>
<td>Lack of biological cues.</td>
</tr>
<tr>
<td>Short chain saturated aliphatic polyesters</td>
<td>FDA approval for various medical applications. Degradation rate, physical and mechanical properties, adjustable by changing the copolymer ratio.</td>
<td>Possible premature fail of scaffold due to bulk hydrolysis. Adverse tissue reactions caused by acidic degradation products. Poor wet ability and lack of cellular adhesion and interaction.</td>
</tr>
<tr>
<td>Poly (E-caprolactone)</td>
<td>FDA Approval for various medical applications</td>
<td>Slow degradation rate (years). Release of acidic degradation products (slower than short chain saturated aliphatic polyesters). Poor wetability and lack of cell adhesion and interaction.</td>
</tr>
</tbody>
</table>

Many researchers most commonly used polymeric materials for medical applications are collagen, gelatin, hyaluronic acid, chitosan, alginate, silk fibroin, fibrin (fibrinogen) and other proteins such as elastin or soybean. Collagen and gelatin have been studied for various medical applications. However impurity and high cost have limited their medical applications (Cheung et al. 2008).
Even chitosan found to have some of the disadvantages like instability, mechanical weakness, low capability of maintaining a predefined shape and impurities associated with it. Similarly, Hyaluronic acid also had the disadvantages like water solubility and shorter residence time on the tissues (Puppi et al. 2010, Pritchard 2011).

2.7 NATURAL EXTRACT COATED MATERIAL USED IN WOUND HEALING

The development of new clothing products, based on the immobilization of natural extract coated materials on textile fabrics, has received growing interest from both academic and industrial sectors (Chen & Chiang 2008). There have been several reports in which the natural fibre based fabrics have been loaded with metal nanoparticles to impart antibacterial properties (Majid Montaze et al. 2011, Rajendran et al. 2010, Perelshtein et al. 2009, Pinto et al. 2009). In most of these studies, the immersion of fabric in solution is commonly followed. The major drawback with such antibacterial textiles is that there are not much controlling factors to regulate the quantity of nanostructure loaded in to the fabric (Perelshtein et al. 2009).

Textiles, especially those made of natural fibers such as cotton, wool, bamboo are an outstanding medium for the growth of microorganisms when the basic requirements such as nutrients, moisture, oxygen and appropriate temperature are present. The large surface area and capability to retain moisture of textiles also assist the growth of microorganisms on the fabric. Hence, there is a great demand for antimicrobial finishes of textiles to control the growth of microorganisms and prevent the textile from deterioration of strength and quality, staining, odors and health concerns caused by microorganisms (Wang & Wang 2009). In recent years inorganic, organic and natural antibacterial finishes have been applied on textile goods.
Some metallic compounds based on metals like silver, copper and mercury refers to inorganic antibacterial agents, which could cause inhibition of the active centers of enzymes (inhibition of metabolism) in terms of control-release mechanism (Hwa Hong & Sun 2008). To improve the protection against the biological threats, usage of antibacterial materials in protective clothing is a good means.

In wound dressings and other medical textile applications due to the potential toxicity to humans and environmental concerns about the use of some of these biocides, naturally-occurring and biocompatible compounds are being preferable. In the recent years there has been upsurge interest in textile technology all over the world for much demanding functionality of the products like wrinkle resistance, water repellence, fade resistance and resistance to the microbial invasion (Mahesh et al. 2011). Today, with the increasing consciousness of environmental concerns, a significant legislation on eco-toxicological considerations has been introduced. Development of antimicrobial textile finish is highly indispensable among various finishes, and relevant since garments are in direct contact with the human body. The antimicrobial (antiviral, antibacterial and antifungal compounds) property plays a very important role, as they are in a straight line contact with the human skin (Rathinamoorthy et al. 2011). The carbohydrates in the cellulosic fabrics serves as the nutrients and the energy sources for the growth of microorganisms, which leads to objectionable odour, stain, discoloration and reduction in the strength properties (Sakthivel et al. 2012).

The products like innerwear and socks remain in touch with the human skin, which are highly flat to sweat over a long period of time that may lead to the skin infections and discomfort to the wearer (Sathianarayanan et al. 2010). For these reasons, it has been the requisite property for a textile to resist or reduce the bacterial growth during use and storage. The rapid growth
in the field of medical textiles and their end uses has generated many opportunities for the application of antimicrobial finishes. Recognizing the importance of plant materials as antimicrobial agents, research has been initiated in identifying the bioactive textiles for the protection of wearer from common microbes causing cross infections.

Natural antimicrobial agents are non-toxic and non-allergenic and do not cause the problems of microbial resistance (Deepti Gupta & Ankur Laha 2007). It is a reality that there is a growing interest in plants with antimicrobial activity. Scientists are progressively more becoming involved in the screening of such plants with the aim of establishing their potential antimicrobial effects and identifying the compounds responsible for the antimicrobial properties (Nwinyi Obinna et al. 2008). Hence, it is indispensible need for more research in the development of ecofriendly antibacterial agents extracted from plants for textile applications. Although certain natural antibacterial agents are available at present, only few studies have been explored for their antibacterial activity on textile materials and also there is need to produce progressive and consolidated statistics on antimicrobial finished product of textiles particularly in the preparation of medical cloths (Joshi et al. 2009). The present study aims at developing an ecofriendly and natural antimicrobial finish on textile fabrics using natural extracts.

2.8 BAMBOO IN MEDICAL APPLICATIONS

The bamboo fiber is made from the starchy pulp of bamboo plants. This textile fiber is fabricated from natural bamboo and other additives. In fact, bamboo fiber is a regenerated cellulose fiber, which is produced from bamboo pulp, processed from bamboo culms. It looks like cotton in its un-spun form. Many bamboo fibers manufactures apply extensive bleaching processes to turn the color of bamboo fiber into white. However, the
companies engaged in producing organic bamboo fabric leave the bamboo fiber unbleached. Bamboo fiber is thinner as compared to hair and has a round and smooth surface which makes it abrasion proof. The fastest growing woody plant on this planet is bamboo. It grows one third faster than the fastest growing tree. Some species can grow up to 1 metre per day. Bamboo is just grass, but it varies in height from dwarf, one foot (30 cm) plants to giant timber bamboos that can grow to over 100 feet (30 m). It grows in many different climates, from jungles to high on mountainsides.

Bamboos are further classified by the types of roots they have. Some, called runners, spread exuberantly, and others are classified as clumpers (sympodial), which slowly expand from the original planting. There are also varieties of root systems that are a mixture of these types. Generally, the tropical bamboos tend to be clumpers and the temperate bamboos tend to be runners. Bamboo is both decorative material and useful. In many parts of the world it is food, fodder, the primary construction material and is used for making a great variety of useful objects from kitchen tools, to paper to dinnerware.

Bamboo has excellent properties that makes it suitable for processing into textile materials. It has been proved that bamboo fiber exhibit an antibacterial property (Renukadevi & Poornima 2007). The fiber is highly water absorbent which could be able to uptake three times of its weight of water. Bamboo fiber has good moisture vapour transmission property, natural effect of sterilization and easy drying. Hence with all these properties it can justified that bamboo fiber based materials can be used as wound dressing materials in medicinal applications.
2.9 CURCUMIN EXTRACT IN MEDICAL APPLICATIONS

Natural products of plant origin have been used for years in medicine and pharmacy for the anticipation and treatment of different diseases. Among these substances, polyphenolic compounds are of scrupulous interest. One of the most widely studied representatives of this group is curcumin (Curc). This is a representative of the curcuminoids-biocompatible and biodegradable polyphenolic compounds, which can be easily metabolized. Curcumin exhibits a wide range of healing properties such as inter alia, antibacterial, antiviral and antitumor (Beevers & Huang 2011). Curcumin is well known for its anticoagulant, (Kim et al. 2011) antioxidant and anti-inflammatory activity (Menon & Sudheer 2007) and is used in wound treatment (Sidhu et al. 1999).

The solubility of curcumin is poor in water and its chemical instability in alkaline medium, and demolition upon enlightenment, along with its low absorption, rapid metabolism, and elimination from the human body predetermine its low bioavailability and limit its applications. Curcumin has been included in liposomes, micelles, nanoemulsions, polymer nanoparticles, or hydrogels with the reason of overcoming these disadvantages and ensuring its therapeutic bioavailability (prolonged circulation in the organism, enhanced absorption, and retardation of metabolic processes, leading to curcumin decomposition). Curcumin possesses a extensive variety of biological properties, which can provide for an broad range of applications of the fibrous materials.

2.10 ALOE VERA EXTRACT IN MEDICAL APPLICATIONS

Aloe vera is attracting the attention of scientists, researchers, and people around the world. Because of the multiple uses of Aloe vera, and the easy growth and maintenance of the plant, many researchers of public and
private sector have gained interest in this plant (Ameetasharma & Shikhagautam 2013). Many original and successful uses of Aloe Vera have come in light due to the researches on Aloe Vera in the field of biology, biochemistry and clinical studies.

The beneficial usefulness of Aloe vera in wound healing and being an anti-inflammatory is due to some constituents of Aloe vera that are complicated in the healing process. It has been noticed in the recent studies, the presence of mannose-6-phosphate, the important sugar is mainly responsible for the wound healing properties of Aloe vera, and thus considered its possibility of being an active growth substance (Ameetasharma & Shikhagautam 2013).

Scientist found an inventive and interesting usage of Aloe Vera gel as an edible coating on fruits and vegetables that act as the healthy additive coating and thus will preserve the excellence and safety of fruits during cold storage. The gel also offers protection from some of the dangerous pathogens by inhibiting their growth, and it also provides numerous health benefits (Choonhakarn et al. 2008). It is because of this reasons, Aloe products are so popular in the market and are widely used in skin care, cosmetics, medical, health care and food industry.

In particular, among all the medicinal plants, Aloe vera has its historic reputation as a curative agent and its extensive use in balancing therapies for a variety of illnesses (Pandey & Mishra 2010). Right now, a huge number of biological activities have been attributed to Aloe vera leaf extracts such as antimicrobial, anti-inflammatory, lipid and glucose lowering, antiproliferative, immunostimulatory, and antioxidant functions (Maharjan & Nampoothiri 2015). The dynamic compounds of Aloe vera include anthraquinones, as aloin, aloe-emodin, acemannan, flavonoids, saponin, sterols, amino acids and vitamins (Hamman 2008). Specifically, it is notable
that the anthraquinones, available in Aloe vera inner gel, have direct antibacterial activities (Fani & Kohanteb 2012).

The antimicrobial activity of Aloe vera inner gel was single-minded against a panel of microorganisms including Gram-positive and -negative bacteria. In addition to Aloe vera inner gel being used in the treatments of both peptic ulcer (Vogler & Ernst 1999) and wound healing, (Banu et al. 2012) it was also experienced on sessile phase of clinical Helicobacter pylori strains.

2.11 CHITOSAN IN MEDICAL APPLICATIONS

Biopolymer like chitosan is a nontoxic, biocompatible, and biodegradable polysaccharide resulting from obviously occurring chitin that has been broadly used in biomedical and pharmaceutical fields (Hansson et al. 2012, Lee et al. 2012, Murakami et al. 2010). Chitosan has the properties such as wound healing capability, to diminish the scars, and antimicrobial growth and inhibition of a broad variety of bacteria which is an advantage in wound healing.


2.12 CALOTROPIS EXTRACT IN MEDICAL APPLICATIONS

Calotropis gigantea is a laticiferous shrubs, commonly known as THE SWALLOW-WORT or MILKWEED. Cardiac glycosides, calotopin, uscharin, calotoxin, calactin and uscharidin, gigantin are present in the latex
of the Calotropis plan. It also contains the protease calotropin DI and DII and calotropin FI and FII. The drawback is that the latex contains some poisonous constituent due to which it has somewhat caustic effect on the mucous membrane and tender skin if it is applied without combination neutrals.

The latex is used in different ways as like bitter, heating, oleaginous, purgative, cures, leucoderma, tumours, ascites. It is also used as caustic, acrid, expectorant, depilatory, anthelmintic, which is also useful in leprosy scabies, ring worm of the scalp, piles, eruptions on the body, asthma, enlargement of spleen and liver, dropsy. It is also applied to painful joint swellings. In the latex of calotropis gigantea show digitalis-like action on the heart. It is also used to induce abortion, infanticide.

Due to the presence of these components, the plants are resistant to phytopathogens where the latex circulates in large quantities. Sharma (2003) screened the major phytochemicals viz. alkaloids, carbohydrates, glycosides, phenolic compounds/tannins, proteins and amino acids, flavonoids, saponins, sterols, acid compounds, resins in flower, bud, root of Calotropis and confirmed its availability in the plant. Hence the leaves are being used in the study as an antibacterial agent.

2.13 EUCALYPTUS EXTRACT IN MEDICAL APPLICATIONS

Arti Dixit et al. (2012) explain that a marvelous amounts of works on Eucalyptus globulus reported it to hold various pharmacological and medicinal properties due to the existence of various phytoconstituents and volatile components. A variety of properties exhibited by the plant comprise antiperiodic, antiphlogistic, antiseptic, astringent, deodorant, anthelmintic, diaphoretic, expectorant, inhalant, insect repellant, rubefacient, sedative yet stimulant, suppurative, and vermifuge. In accumulation, the blue-gum eucalyptus is considered as a folk remedy for abscess, arthritis, asthma, boils,
bronchitis, burns, cancer, cold, cough, diabetes, diptheria, dysentery, dyspepsia, fever, inflammation, malaria, miasma, sorethroat, spasms, tuberculosis, tumors, vaginitis, wounds, and worms.

The eucalyptus oil has been extensively acknowledged as an antiseptic, the evidence of which has been recognized in vitro on many germs. Additionally, eucalyptus oil (0.05-0.2mL/day) has been reported to own powerful expectorant and mucolytic properties, which stimulates the bronchial epithelium. Similar to menthol, eucalyptus oil is understood to decongest the upper respiratory tract in case of common cold, the action being the stimulation of receptors normally stimulated by the incoming nasal air flow. However, at higher doses, eucalyptus oil has been reported to behave like a neurotoxic (LD=1.7ML/Kg.rat.IP) agent.

Furthermore, the hydroalcoholic leaf extract of the plant showed strong antibacterial activity, particularly against cariogenic bacteria in the mouth. Added to the point, the phloroglucin derivative isolated from leaves showed anti-inflammatory movement which was evidenced by the fact that when compared with indomethacin, the derivative showed improved anti-inflammatory activity. In addition, the oral administration of Eucalyptus globules extract has been noted to decrease the alloxan-induced oxidative stress, accounting for its antioxidant effects. In spite of the absence of clinical trials to demonstrate the indisputable therapeutical interest of eucalyptus oil, the product is the chief ingredient of many proprietary drugs because of its potent antiseptic and decongestant activity.

Therefore, the dosage forms similar to syrups, lozenges, nasal drops, and inhalations have been planned to treat the symptoms of ordinary respiratory disorders. Furthermore, phytopharmaceuticals on eucalyptus leaves have been conventionally used to treat sensitive benign bronchial disease, and to relieve nasal congestion in the common cold. Additionally,
Eucalyptus has also been used for treating catarrh of upper respiratory and bronchitis. And also, the tannin isolated from the plant has been shown to exert potent astringent effect on the inflamed mucous membranes of the throat, that further account for its therapeutic potential.

2.14 SYZYGIUM AROMATICUM EXTRACT IN MEDICAL APPLICATIONS

Debjit Bhowmik et al. (2012) states Syzygium Aromaticum (Cloves) are an fragrant herb that has many useful purposes. The aroma of the clove is pleasing yet highly spiced and can be used to make drawers and closets odor nice. Cloves has some medicinal purposes as well and it tastes good in definite dishes like spice cake. Cloves used to grow in hot tropical climates. The clove plant is an evergreen tree that can attain a height of thirty or forty feet high. The leaves of the clove are leathery textured and are covered with many tiny depressions. The part of the clove that is used is the flower buds of the clove. The aromatic oils of the clove have a stimulant and irritant effect.

Cloves can boost blood circulation and raise a person's temperature slightly. The oils of the cloves have been known to arouse and sterilize a body as it travels in the course of the body. Clove can be used to promote the flow of saliva and gastric juices.

The antibacterial property of Syzygium Aromaticum (Cloves) is an effective aid for food poisoning, clove oil effectively kills many forms of bacterial infections from contaminated foods.

Medicinal uses Clove cane be understood from the researchers statement that, Clove oil is formed by a steam distillation process. Clove oil is an curiously powerful antioxidant. Antioxidant capacity is measure by
Oxygen Radical Absorption Capacity (ORAC). Even though the dried buds or powders rank highly among anti-oxidants, clove oil is the monster antioxidant.

Western studies have proved the use of cloves and clove oil for dental pain. Though, studies to determine its usefulness for fever reduction, as a mosquito repellent and to avoid premature ejaculation has remained inconclusive. Clove may reduce blood sugar levels. Tellimagrandin II is an ellagitannin established in Syzygium Aromaticum (Cloves) with antitherpes virus properties.

The buds have antioxidant properties. In addition, Clove oil is used in research of some toothpastes, laxative pills and Clovacaine solution which is a local anesthetic and used in oral ulceration and anti-inflammations. Eugenol (or clove oil generally) is mixed with Zinc oxide to be a temporary filling.

2.15 NEEM LEAF EXTRACT IN MEDICAL APPLICATIONS

Researcher Uwimbabazi Francine et al. (2015) sates that Neem commonly called ‘India Lilac’ or ‘Margosa’, belongs to the family Meliaceae, subfamily Meloideae and tribe Melieae. Neem is the most flexible, multifarious trees of tropics, with immense potential. It possesses important helpful non-wood products (leaves, bark, flowers, fruits, seed, gum, oil and neem cake) than any other tree species. A variety of parts of the neem tree have been used as traditional Ayurvedic medicine in India. Neem oil and the bark and leaf extracts have been therapeutically used as folk drug to control leprosy, intestinal helminthiasis, respiratory disorders, and constipation and also as a general health promoter. Neem oil finds use to manage different skin infections. Bark, leaf, root, flower and fruit together cure blood morbidity, itching, skin ulcers, burning sensations and phthisis.
Neem effect on bacteria E.coli was determined which shows resistance on all extracts used. Ethanol extracts were more well-organized in all cases whether for dry and fresh neem barks and leaves. Fresh leaves are superior in their efficiency compared to dry leaves. Bark results did not reveal the dissimilarity in their effect on S.aureus. The information provided by the study on antibacterial effect of Azadirachta indica, makes it easier for quantity determination and chemotherapeutic index of the extract if they were to be processed into drugs.

Lastly, based on the information got from researchers study the antibacterial effect of Neem can change depending on Neem parts used, the solvent used, even the state of the material used whether it is dry or fresh, furthermore the extract concentration matters a lot because each extract has its least amount inhibition concentration (MIC) which is the highest dilution of a plant extract that still retain an inhibitory effect against the growth of a microorganism.

2.16 PIPER BETEL EXTRACT IN MEDICAL APPLICATIONS

In the study of Ramyaa & Maheshwari, (2015) it was aimed in developing an ecofriendly and natural antimicrobial finish on textile fabrics using the extracts of Piper betel. This belongs to a family Piperaceae and is commonly known as ‘Paan’. The parts of Piper betel utilized for different purposes are leaves, roots, stems, stalks and fruits. Betel leaf has wide antiseptic properties. The use of betel leaf as an antiseptic is increasing. The energetic substances in betel leaf are phenol and its derivatives.

The phenolic derivatives found in betel leaves have a five-fold greater antibacterial potency than phenol itself. The treatments with the Piper betel reduce microbial growth as is evident from the absence of growth under the treated samples.
The Piper betel treated samples show an antisepsis benefit ranging from 53% to 86% of the antisepsis advantage of the antibiotics against Staphylococcus, Klebsiella, Pseudomonas and Proteus, but as in the case against Bacillus the Piper betel treated samples show 50% higher antisepsis than the Cefixime antibiotic.

2.17 EPIDERMAL GROWTH FACTOR (EGF) IN MEDICAL APPLICATIONS

Human EGF (hEGF) was first one-off in 1975 and has been shown to contain 53 amino acids it has been acknowledged in various human tissues and fluids including urine, saliva, plasma and breast milk. Human EGF has newly been synthesized with recombinant DNA techniques, which has provided enough quantities of rhEGF for preclinical and clinical assessment (Brazzell et al. 1991). Direct delivery of rhEGF at the wound site in a sustained and controllable way without loss of bioactivity would enhance its biological effects (Zhou et al. 2011).

Ryu et al. (2009) also confirm that many researchers challenge various growth factors to study the environment of wounds and to improve wound healing. The outcome found that key elements in wound healing, includes Platelet-Derived Growth Factor (PDGF), Transforming Growth Factor-β (TGF-β), Fibroblast Growth Factor (FGF), Keratinocyte Growth Factor (KGF), and Epidermal Growth Factor (EGF) which can generate tissue regeneration and the remodeling wound healing process.

In the present study a wound dressing material coated with natural extracts is developed and coated with rhEGF, and investigated for its drug-releasing efficacy on wounds. To gain further knowledge about the developed wound dressing material with respect to wound healing, in vivo study was also undertaken.