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# Some Significant Developments in Bandage Fabrics

**Gokarneshan N***

Formerly professor and head, Department of Textile technology, Park college of engineering and technology, Coimbatore, Tamil Nadu, India

***Corresponding author:** Gokarneshan N, Formerly professor and head, Department of Textile technology, Park college of engineering and technology, Coimbatore, Tamil Nadu, India, E-mail: advaitcbe@rediffmail.com

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## Abstract

The article provides some useful insights on bandage cloths as pointed out by some significant researches. Some work has been focused on medical bandages. In the construction of bandages, cotton, bamboo and cotton/bamboo have been selected. In order to enhance the functional properties finish has been given that include antimicrobial using triclosan, vitamin E and aloe vera. The woven bandages have been tested for antimicrobial activity, comfort and aesthetic property. In another interesting study, attention has been directed towards treatment of some orthesis and non-orthesis bandages of organs wounds, then comparing it what is currently available in hospitals and pharmacies. To improve the functional properties of these bandages they gauze fabrics treated by different concentrations of honey and chitosan mixture (Chitoasllona, CA), other samples of gauze fabrics with treated honey and chitosan mixture flowed by modifier medical gypsum (Gybschitoasallona, GCA) for treatment orthopedic organs wound, the treated fabrics have been exposed to microwave radiation. The important findings of the studies have been highlighted herein. Compression garments are special textile products which apply a pressure on needed body zones for supporting medical, sport or casual activities. Medical bandages are a group of these garments and they have a very common usage for compression effect on legs or arms. These bandages are generally produced by using synthetic raw materials such as polyamide or polyester fibres. Medical bandages are in contact with skin. Even if the synthetic fibres are used, they may cause both comfort and health problems like allergies. Nowadays in textile sector, the expectations of clients include using of natural fibres as far as possible in all garments. Natural fibres have good advantages such as breathability, softness, moisture management ability, non-allergenic and ecologic structure and these characteristics present optimum utilization conditions.

**Keywords:** Antimicrobial; Absorbency; Compression Garments; Medical Bandages; Functional Finish; Wound; Gauze Fabrics

## Introduction

A bandage is a piece of material used either to support a medical device such as a dressing or splint, or on its own to provide support to the body [1]. A wound is an injury that causes either an internal or external break in body tissue or it is a type of injury in which skin is torn, cut or punctured which damages the dermis of the skin. The main effects that comes along with wound are infection, change in appearance of skin and odor of blood bled [2]. To overcome the above mentioned effects, an antimicrobial finish to improve antibacterial activity, vitamin-E finish which helps in reducing scars, stretch marks and introduce fragrance to mass the odor was given to the bandage cloth which is of cotton and bamboo.

Egypt now occupies the first place in the world in road accident with the asphalt consequent bleeding and the increase of the numbers of death and injuries which include fractures with some cutting injuries and other...etc. Which requires intensive care in dealing with these wounds [3,4]. Skin as the main part and the largest in the face of the body with the outside world, so it's possible that the skin injuries arises because of the direct penetration of microorganisms for proper skin and increasingly so in the hot weather and high humidity which help the growth of bacteria and we use medical bandages which is available in pharmacies such as orthesis, non orthesis bandages of organs wound according to patient condition which requires that patient to keep it for a long period which must accompanied by some negative effects on the patient during the summer months when they multiply microorganisms quickly if moisture, oxygen, food and temperature are available and this affect the skin with hypersensitive effects [5-7].

Compression therapy is a form of healing that has been utilized since the time of Hippocrates (450-350 BCE) and has been applied as therapy for treating diseases such as vein disorders or oedemas. The working mechanism of compression therapy is an external application which applies compression to the skin in order to support the superficial venous system. This pressure forces the veins to narrow and there is a reduction in the volume of blood in the veins. As a result, the calf muscle pump can work better and the bloodstream is more easily able to move up toward the heart. Thus there is higher tissue oxygenation and better micro circulation [8]. This review intends to highlight the recent research trends in bandage fabrics which indicate the scope for wider applications and more effectiveness in use.

## Comparison of Some Commercially available Antimicrobial Agents

### Triclosan

**Advantages**

a) It is an antibacterial and anti-fungal agent that slows or stops the growth of germs such as bacteria and mildew.
b) It is widely used as an antimicrobial ingredient in surgical hand scrubs and hand washes in hospitals and other healthcare facilities.
c) In toothpaste, triclosan can help combat the bacteria that cause gingivitis.
d) Triclosan is found in over-the-counter consumer antiseptic products such as hand wipes, rubs or gels, which can be used to clean hands when water is unavailable.

**Disadvantages**

a) The efficacy of the ingredients is not proved.
b) It might contribute to the development of antibiotic resistant bacteria.
c) It's linked to the following effects on human health: Abnormal endocrine system/thyroid hormone signaling. Weakening of immune system.Children exposed to antibacterial products at an early age has an increased chance of developing allergies, asthma and eczema.

### Chitosan

**Advantages**

a) Used in medicine
b) Treat obesity, high cholesterol, and Crohns disease
c) Treat complications that kidney failure patients on dialysis often face including high cholesterol

## Functional Finish of Bandages for Hospital use

Aloevera finish is been given to make the patient feel cool and the gel plays significant role in wound healing. In the current study, fibers used are cotton and bamboo. Cotton, as a natural cellulosic fibre, has a lot of characteristics, such as Comfortable Soft hand, Good absorbency, Colour retention, Good strength, Drapes well, Easy to handle. The major advantage for choosing cotton is that it is cheaper one. But it does not possess any special function on its own nature [9]. Whereas, Bamboo fiber has particular and natural functions of anti-bacteria, bacteriostasis and deodorization. Bamboo fiber is biodegradable textile material and so it can be biodegraded in soil by microorganism and sunshine. The decomposition process doesn't cause any pollution to environment [10]. Use of bandage cloth is disposable way of dressing. Several researchers have used antimicrobial finishes to provide bandage cloth fabrics with barriers against micro organisms. The present study aims at developing bandage clothes having antimicrobial nature by imparting antimicrobial finish to it.

## Evaluation of Antimicrobial Activity

Figure 1 and 2 shows the antimicrobial effectiveness of triclosan against the standard test cultures such as S.aures and E.coli organism respectively. As the microbes initially lay over the plate has been killed and could not proliferate to produce a lawn in

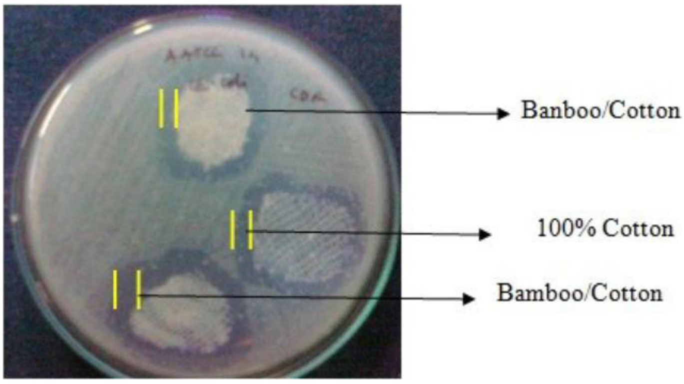



**Figure 1:-** Antimicrobial activity against E.Coli (treated)

its surrounding. A clear zone of inhibition is visible on treated bandage cloth for both the test cultures [11]. In figure 3, there is no inhibited zone around the untreated bandage cloth and is completely surrounded by the colonies of bacteria. Bamboo has got antimicrobial nature by its own but the antimicrobial activity of bamboo can be seen when it is in contact with skin. The study confirms the antimicrobialnature of triclosan finished bandage cloth.

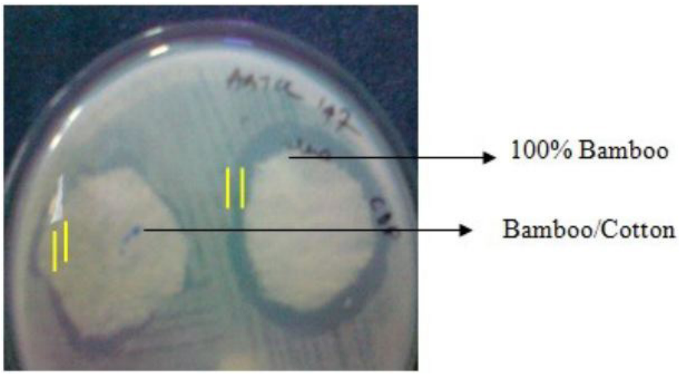



**Figure 2:** Antimicrobial activity Against S.aureus (treated)

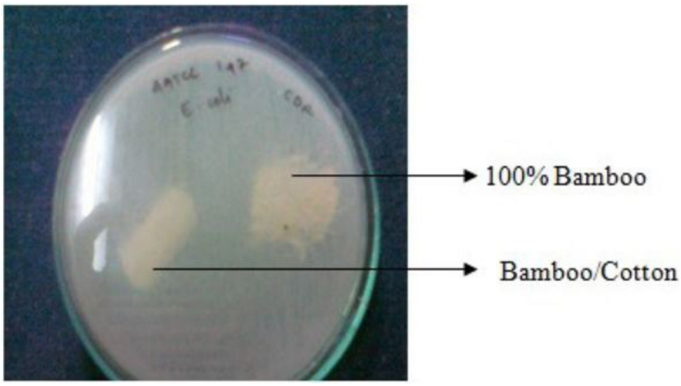



**Figure 3:** Antimicrobial activity (Untreated bandage cloth)

Here the broad spectrum of antimicrobial activity is good in treated bandage cloth of 100 % bamboo, 100% cotton and bamboo – cotton. It is to be noted that even though triclosan is known to have some side effects in its use, the research has finished the treated fabric by use of aloe vera which could possibly reduce the adverse effects of triclosan and make the fabric more biocompatible to the patient.

## Influence of Absorbency on Untreated and Treated Fabrics

Table 2 shows that the time taken to absorb blood and water molecules by treated vital finish samples is comparatively less with respect to the untreated samples. The Aloevera finish makes the cloth softer and thus the absorbency is higher than untreated cloth.

| Samples | Time taken for water molecules (seconds) | | Time taken for blood molecules (seconds) | |
|---|---|---|---|---|
| | Before finish | After finish | Before finish | After finish |
| 100% Bamboo | <2 | <1 | <3 | <2 |
| 100% cotton | <4 | <3 | <6 | <4 |
| Bamboo-Cotton | <3 | <2 | <4 | <3 |

**Table 2:** Absorbency test on Treated and Untreated samples

Among the three untreated samples (100% bamboo, 100% cotton and bamboo- Cotton) bamboo behaves higher in absorbency [11]. Since bamboo is the softer and hollow in nature and hence enhances higher absorbency. Whereas, the absorbency of bamboo – Cotton is higher than that of 100 % Cotton. Among the three treated samples (100% bamboo, 100% cotton and bamboo- Cotton) bamboo behaves higher in absorbency. Whereas the absorbency of cotton is higher than that of bamboo – Cotton.

## Wicking

The Figures 4 and 5 shows that the wicking property of the treated samples is effective when compared to the untreated samples. The reason behind this is the samples are treated with vitamin Eand triclosan which provide wickability for the better transport. Treatment of fabric with Aloevera will also improve the absorbency and wickability. Among the three untreated samples (100%

bamboo, 100% cotton and bamboo- Cotton) bamboo have higher wickability. Since bamboo becomes softer and more absorbent it enhances higher wickability. Whereas the wickability of bamboo – Cotton is higher than that of Cotton [11].

Among the three treated samples (100% bamboo, 100% cotton and bamboo- Cotton) bamboo have higher wickability. Whereas the wickability of bamboo – Cotton is higher than that of Cotton.

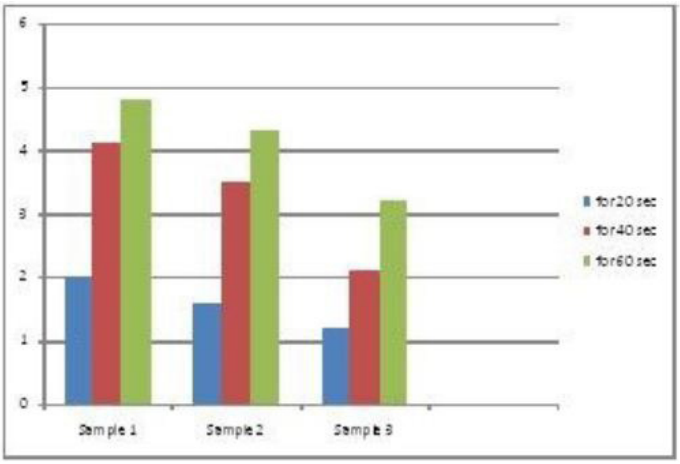



**Figure 4:-** Wickability Vs Untreated fabrics

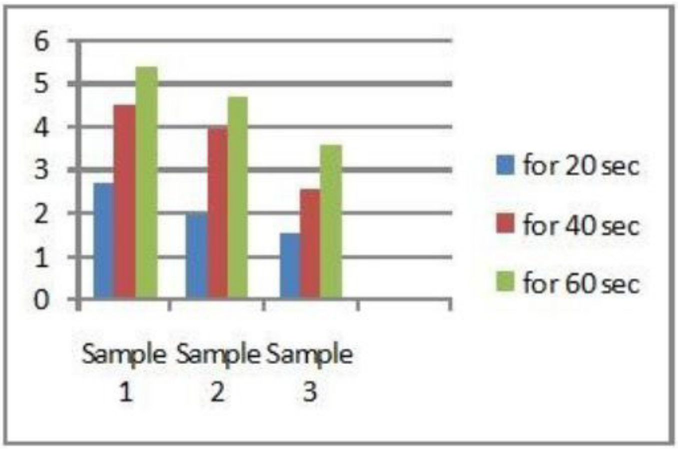



**Figure 5:-** Wickability Vs treated fabrics

## Staining

The treated and untreated samples were tested physically for the stains of blood under normal condition. From Table 3 it is seen that bamboo performs faster on stain release.

| S.No | Gauze Fabrics | Bandage type Bandage | Trade Name | Treatment materials g/g/L | Treatment Concentration medical | Concentration of modifier gypsum | Microwave Energy W/sec |
|---|---|---|---|---|---|---|---|
| **1** | **Gauze** | **Non orthesis** | Gauze | -- | - | - | - |
| 2 | | Bandages | Asallona | Honey | 20 | - | 510/10 |
| 3 | | of organs | Chitosona | Chitosan | 5 | - | 510/10 |
| 4 | | | Chitoasllona | - | 20/5 | - | 510/10 |
| 5 | | | | | 20/10 | | 510/10 |
| 6 | | | | | 20/15 | | 510/10 |
| 7 | | | | | 30/5 | | 510/10 |
| 8 | | | | | 30/10 | | 510/10 |
| 9 | | | | | 30/15 | | 510/10 |
| 10 | | | | | 40/5 | | 510/10 |
| 11 | | | | | 40/10 | | 510/10 |
| 12 | | | | | 40/15 | | 510/10 |

| S.No | Gauze Fabrics | Bandage type Bandage | Trade Name | Treatment materials g/g/L | Treatment Concentration medical | Concentration of modifier gypsum | Microwave Energy W/sec |
|---|---|---|---|---|---|---|---|
| 13 | Gauze | Orthesis | Gypsona | -- | -- | -- | -- |
| 14 | Bandages | Gauze | -- | -- | -- | -- | 510/10 |
| 15 | | of organs | Gybs | Honey | 20 | 20g Chitosan /200g CMC | 510/10 |
| 16 | | | Asallona | Chitosan | | /1Kg Medical | 510/10 |
| 17 | | | Gybs | Honey/20/5 Chitosan | | Gypsum | 510/10 |
| 18 | | | Chitosona | | 20/10 | | 510/10 |
| 19 | | | GCA | | 20/15 | | 510/10 |
| 20 | | | | | 30/5 | | 510/10 |
| 21 | | | | | 30/10 | | 510/10 |
| 22 | | | | | 30/15 | | 510/10 |
| 23 | | | | | 40/5 | | 510/10 |
| 24 | | | | | 40/10 | | 510/10 |
| 25 | | | | | 40/15 | | 510/10 |

**Table 3:** Comparison of various bandages

## Deodorizing Activity of Finished and Unfinished Bandage Cloth

The score sheets reported that the finished bandage cloths have good performance towards odour massing property and they were comfortable to wearer. Also the report encloses that there were no allergies or itching to the patients while wearing the finished bandage cloth.

In current scenario, medical textiles plays vital role in hospital applications. Bandages are found to be intimate with the patients and so it is important to provide bandage cloth with barrier against microorganisms and odor of blood. The functional finishes imparted shows antimicrobial activity and it is assessed using agar diffusion method. The result shows higher resistivity about 0.4 mm of zonal inhibition against *E.Coli* and *S.Aureas.* The comfort property and physical property seems to be good in bamboo bandages [11]. Moreover it has got antimicrobial nature by its own but the antimicrobial activity of bamboo can be seen when it is in contact with skin. Therefore it can be concluded that bamboo bandages can be used for accidental wounds. Whereas treated bamboo-cotton equally proved to have better properties can be used for patients at trauma conditions.100% cotton can be treated with triclosan and used for patients to avoid infections from microbes. The finishes such as Aloevera and vitamin E resulted in excellent fragrance and improvement in skin tone after the use of bandage cloth.

## Evaluating Functional Properties of Special Bandages

Bacteria turning urea that result from race to ammonia causing rashes, allergies and skin irritation helping it to increase the nomination of the wound cells to some secretions in addition to sweating and accumulating of gypsum and body surface by unencumbered consists pus because the center will be suitable for the growth of bacteria that irritate the skin and given a sense of itching and allergies and the patient may have to remove gypsona by himself or the doctors remove and clean the wound again then reestablish a new medical bandages [12,13]. The resistant fabrics laces of bactria and microbes consider as an important property of this topic [14]. So the researches sought to overcome these problems by treatment orthesis and onorthesis bandages of organs wounds using honey, Chitosan, CA and GCA bandages.

Fabrics antibacterial has been developed by inhibiting antibacterial activity and reached to improve the physical properties of cotton fabrics treated to increase the concentration of chitosan derivatives rates. Wounds bandaged were loaded with silver nano practices to act as an anti-bacterial. Another study has been able to produce chitosan and its use in medical textiles, and proved that it helps to increase absorption of cotton textiles of different dyes [15]. Another study found that, the production of cotton fabrics anti-bacterial and UV using chitosan.

It has been possible to form the production of medical gauze to treat wound using capsules in the presence of UV ozone in the presence of ozone component of honey and chitosan concluded that it can successfully use these capsules in bandages injuries and it proved resistance to bacteria and speed wound healing [16,17]. Lately they invent a bandage to the wounds of chitosan that is absorbed by the body, it uses a thin internal wounds and help heal wounds and don t use sensitivities, also noted by to the possibility of using sound waves to treat and clean various wounds and concluded that the wounds heal more with the sound waves from the normal treatment [18]. Also they produce a smart bandage of medical adhesive plaster in color from yellow to magenta, change by the case of the wound, and help to examine the wound regularly from abroad without impeding the healing process [19].

The aim of this study is to reach the suitable concentration of treatment material for orthesis and non-orthesis fabric bandages of organs wounds under research, which gives the best properties compared to what is available in hospitals and pharmacies.

## Fabric weight

The variation of fabric weight per square meter according to the variation of honey and chitosna concentrations for non-orthesis "CA" and orthesis "GCA" bandages of organs have been determined. The statistical analysis showed that both independent variables have a profound effect on fabric weigh for both types of bandages at 0.01 significant levels. From both Figures, an increasing trend was detected assuring that as the levels of both variables increases the weight of both bandages also increases [20].

The statistical analysis proved that increasing the honey concentration from 20% to 40% leads to an increase of weight per square meter by 28% and 3% for nonorthesis and orthesis bandages of organs respectively. With regard to the effect of chitosan, it was found that increasing its concentration increased the weight of nonorthesis "CA" and orthesis "GCA" bandages of organs by approximately 23% and 3% respectively.

The regression relationship which correlates honey and chitosan concentrations with the Weight per square meter for both nonorthesis "CA" and orthesis "GCA" bandages of organs have non-linear form.

The coefficient of determination of these models equal to 0.88 and 0.93 respectively, which means that these models fits the data very well. Regardless of the effects of honey and chitosan concentration, it was found a huge difference between non-orthesis "CA" and orthesis "GCA" bandages of organs with respect to their weights per square meters. The orthesis bandages of organs exhibited higher weight than non-orthesis ones. The average values of weight with gram per square meter for non-orthesis "CA" and orthesis "GCA" bandages of organs were 102 and 350 g/m2 respectively. This is due to treatment of orthesis bandages "CA" fabrics with modifier Medical Gypsum.

## Fabric Tensile Strength

Tensile strength has been accepted as one of the most important attributes of textile fabrics. The strength of a woven fabric depends not only on the strength of constituent yarns, but also on the yarn and fabric structure and the type of finishing and treatments. The variation of tensile strength of woven fabrics according to different levels of chitosan and honey concentrations for orthesis "CA" and non- orthesis "GCA" bandages of organs have been determined. The statistical analysis proved that for orthesis bandages of organs, both honey and chitosan concentrations have no significant influence on their tensile strength. Whereas in the case of non-orthesis bandages of organs, the honey concentration was found to have a significant effect on fabric tensile strength at 0.01 significant level. From these Figures, an increasing trend was detected assuring that as the both factor levels increases the tensile strength react in the same manner for both types of bandages [20]. It was found that increasing honey concentration from 20% to 40 % leads to an increase of bandage tensile strength by approximately 9% and 10% for non-orthesis and orthesis bandages respectively. Increasing the chitosan concentration from 5% to 15% causes the increase of non orthesis bandage tensile strength by about 8.2%. The statistical analysis also showed that honey concentration accounted for 16% the variability in tensile strength and that chitosan accounted for 28% odf the nonorthes is bandages. In the case of orhesis bandages, the honey and chitosan concentrations accounted for 67% and 5% respectively the variability in the fabric tensile strength.

To predict the tensile strength of orthesis "CA" and non orthesis "GCA" bandages, non-linear regression models can be used. The statistical analysis proved that the coefficient of determination for these models was 0.92 and 0.87, which means that these models fit the data very well. Irrespective the levels of honey and chitosan concentrations, the orthesis and non-orthesis bandages of organs were found to differ significantly at 0.01 significant levels in relation to their tensile strength. The statistical analysis showed that the tensile strength of orthesis bandages "CA" of organs surpasses the non-orthesis"GCA" ones by 10%.

## Fabric Breaking Extension

Equally important to the fabric tensile strength is its ability to extend under load. When the fabric is subjected to tension in one direction, the extension takes place in two main phases. The first phase is decrimping or crimp removal in the direction of the load. The second phase is the extension of the yarn, during which the fabric becomes stiffer, the stiffness depending mainly on the character of the yarn. Breaking extension versus honey and chitosan concentrations for non-orthesis and orthesis bandages of organs have been determined. The statistical analysis proved that chitosan concentration has a significant influence at 0.05 significant levels on breaking extension of non-orthesis bandages, whereas honey concentration has a significant impact on breaking extension of non-orthesis bandages. From these Figures an increasing trends were detected conforming that as the concentrations of chitosan and honey increase the breaking extension of both orthesis bandages increase [20].

Increasing the honey concentration from 20% to 40% leads to an increase of breaking extension for both types of orthesis organs by 17%. While increasing the chitosan concentration augmented the breaking extension of non-ortheis and orthesis bandages by about 37% and 10% respectively.

Irrespective of the type of treatment, the statistical analysis showed that there is not a significant difference between two types of bandages with respect to their breaking extension.

The regression relationship which correlates the levels of chitosan and honey concentrations to the breaking extension of orthesis and non-orthesis bandages of organs has non-linear forms. The statistical analysis proved that the coefficient of determination for both regression models equal 0.91 and 0.94 respectively, which means that these models fit the data very well.

## Fabric Thickness

Fabric thickness is important since it affects permeability and insulation characteristics of fabric. Also, thickness changing of the fabrics gives an idea about the bulkiness of the fabric under different pressures. The effects of honey and chitosan concentrations on thickness of non-orthesis and orthesis bandages of organs have been determined.

The statistical analysis proved that both independent variables have a profound influence on thickness of both types of bandages at significant level 0.01. As shown in Figures 7 and 8, both types of independent variables have a positive effect on bandage thickness. As the both variable levels increase the bandage thickness has the same trend [20].

It was found that increasing honey concentration from 20 to 40 % leads to an increase of bandage thickness by approximately 10% and 38% for nonorthesis and orthesis bandages of organs respectively. While increasing chitosan concentration from 5 to 15% leads to an increase of bandage thickness by about 7% and 17% for non orthesis and orthesis bandage of organs.

The statistical analysis also showed that honey concentration accounted for 32% and 75% the variability in thickness of nonorthesis and orthesis bandages of organs, respectively. While chitosan concentration accounted for 32% and 14% the variability of thickness of non-orthesis and orthesis bandages of organs.

The regression relationship correlates the honey and chitosan concentrations with the thickness of non-ortheis and orthesis bandage of organs. The statistical analysis proved that the coefficient of determination for both regression models equal 0.0.82 and 0.89 respectively, which means that these models fit the data very well. Irrespective of the levels of honey and chitosan concentrations, it was found that thickness of orthesis bandage of organs exhibited higher values compared to the corresponding values of non-orthesis bandage of organs. The average thickness values of non-ortheis and orthesis bandage of organs were 0.5 mm and 0.6 mm respectively.

## Fabric Stiffness

Stiffness is one of the most widely used parameters to judge bending rigidity and fabric handling. Fabric stiffness and handling is an important decision factor for the end users. The degree of fabric stiffness is related to its properties such as fiber material, yarn and fabric structure. In this work, the effects honey and chitosan concentrations thickness of non-orthesis and ortheis bandages was investigated. The statistical analysis proved that honey concentration has a significant influence on stiffness of both types of bandages. Whereas the chitosan concentration was found to have a significant effect on stiffness of orthesis bandage of organs only [20].

It has been observed that an increasing trend was detected assuring that as the levels of both variables increases, the stiffness of orthesis bandage also increases. Increasing honey concentration increased the stiffness of non-ortheis and orthesis bandages of organs by approximately 20% and 22% respectively. While increasing the chitosan concentration from 5% to 15% leads to an increase of stiffness by about 20% and 19% for non-orthesis and orthesis bandages of organs respectively.

The statistical analysis showed that chitosan concentration accounted for 35% the variability of stiffness of both types of bandages. Whereas honey concentration accounted for 12% and 29% the variability of stiffness of non-orthesis and orthesis bandages of organs respectively.

The non-linear regression models correlate the levels of chitosan and honey concentrations with stiffness of both types of bandages. It is also found that the average value of stiffness of orthesis bandage of organ is higher compared to the corresponding values for non-orthesis bandage of organs. The average values of stiffness of nonorthesis and orthesis bandage of organs have been determined.

## Fabric Absorption

The absorbency of treated fabrics is measured by drop penetration method. The effects of chitosan and honey concentrations on absorption time for non-orthesis and orthesis bandages have been determined.

The statistical analysis proved that both independent variables have a significant influence on absorption time for nonorthesis bandages of organs only. It was found that there is no effect for these variables on absorbency on the other bandage type [20].

Following the physical and mechanical properties of non-orthesis and orthesis bandage of organs, additional testing was performed to determine the antimicrobial capabilities of these types of bandages. The antimicrobial properties were conducted against Gram-positive bacterium (S. aureus) and Gram-negative (E. coli) respectively.

The regression relationship correlates the absorbency of non-orthesis and orthesis bandage of organs with the honey and chitosan concentration. The coefficient of determination for these

## Antimicrobial Properties

Following the physical and mechanical properties of non-orthesis and orthesis bandage of organs, additional testing was performed to determine the antimicrobial capabilities of these types of bandages. The antimicrobial properties were conducted against Gram-positive bacterium (*S. aureus*) and Gram-negative (*E. coli*) respectively.

### Antimicrobial Properties against *E. coli*

The response surface of the effect of honey and chitosan concentration on antimicrobial activity against *E. coli* for non-orthesis and orthesis bandages of organs have been determined. The statistical analysis proved that both independent variables have a profound effect on antimicrobial activity for both types of bandages. From both figures an increasing trend was detected assuring that as the honey and chitosan concentration increases the antimicrobial activity against *E. coli* also increases for both types of bandages.

Increasing honey concentration from 20% to 40% increases the antimicrobial activity by 31% and 40% for non orthesis and orthesis bandages of organs. While increasing chitosan concentration from 5% to 15% leads to an increase of antimicrobial activity for both types of bandages by approximately 45% and 41 % respectively [20].

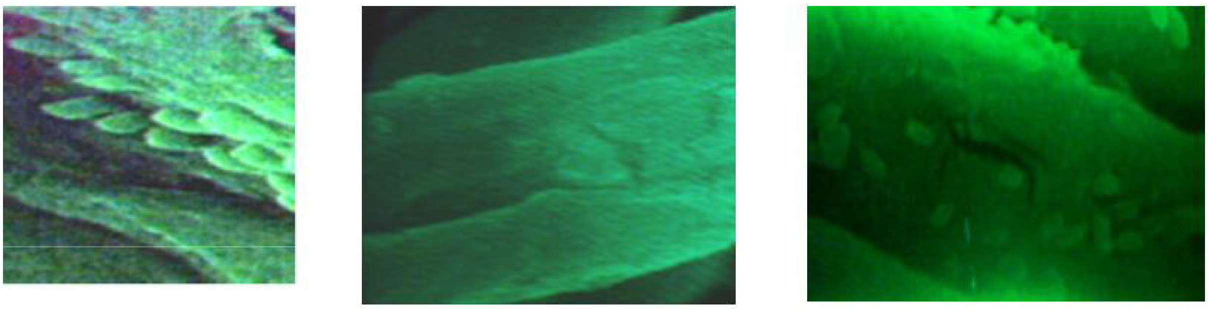
The statistical analysis also proved that the effects of honey concentration accounted for 15% and 35% of the variability in antimicrobial activity for non-orthesis and orthesis bandages. Whereas the concentration of chitosan accounted for 54% and 47% of the variability in antimicrobial activity for non orthesis and orthesis bandages respectively.

This is due to cover some of non orthesis fabrics bandages porosity with modifier medical gypsum. The regression relationship correlates the concentration of chitosan and honey with the antimicrobial activity against E. coli. The coefficient of determination for these models is equal to 0.90 and 0.92 respectively, which means that these models fit the data very well.

### Antimicrobial Properties against *S. aureus*

The effects of chitosan and honey concentration against antimicrobial activity of *S. aureus* have been determined for non-orthesis and orthesis bandages of organs. The statistical analysis showed a significant influence of both factors on the antimicrobial activity at 0.01 significant levels. From these Figure 6a,b and c an increasing trend was detected assuring that as the concentration of both independent variables increases the antimicrobial activity against *S. aureus* also increases for both types of bandages. Increasing honey concentration from 20% to 40% leads to an increasing of antimicrobial activity for non-orthesis and orthesis bandage by approximately 46% and 55% respectively [20]. Whereas increasing the chitosan leads to an increase of antimicrobial activity for both types of bandages by 44% and 82% respectively.

The regression relationship correlates the concentration of chitosan and honey with the antimicrobial activity against *S. aureus.*



(a) (b) (c)

**Figure 6a,b and c:**
a) SEM of untreated gauze fabric "Gypsona"
b) SEM of treated fabric "GCA"
c) SEM of treated fabric "CA"

The coefficient of determination for these models is equal to 0.90 and 0.92 respectively, which means that these models fit the data very well. Antibacterial activity of the treated and untreated fabric Against *E. coli* (gram negative) and *Staphylococcus aureus* (gram positive). The antibacterial activity has been seen to be diagonal of the treated and untreated fabric Against *E. coli* and *Staphylococcus aureus*. A high growth of bacteria has been noticed on untreated gauze fabric with Chitosan & honey, while the surface of gauze fabric treated gave resistant bacteria.

Chitosan & honey has been seen on fabric surface. The practice of this application has proved fractures and wound healing speed of patients in the university hospital increased by 12%, 17 % when using CA and GCA bandages which compared with available presently bandages in hospitals and pharmacies.

The results showed that when the concentration rate of honey, chitosan mixture and honey, chitosan mixture, modifier medical gypsum are increased the measured functional properties improved, and appears excellent bactericidal activity in CA and GCA fabrics [20]. The SEM pictures reveal that honey, chitosan and modifier medical gypsum are deposited on the surface of fabric fibers and reduction of bacteria on the fabrics surfaces.

## Innovative Medical Bandage with Improved Comfort

Compression garments have a special function, which apply a certain pressure to the body mainly for medical, sports and body shaping [21]. Most medical compression garments are individually designed and manufactured for a particular part of body, such as stockings, gloves, sleeves, face masks and body suits [22]. Medical bandages are strip or tube form of materials used to protect, immobilize, compress or support needed body parts and they are most common groups of compression garments. They provide a compression pressure by wrapping body parts to support an injured limb, muscle or joint. There are different types of compression bandages such as long stretch, short stretch etc. Medical bandages are cheap and common equipment for compression therapy but there are some difficulties of using for patients. Even if new bandage systems have easy utilization process, the users need an expert help to adjust right pressure values for a successful treatment [23-26].

The success rate of compression treatment is directly related to right pressure profile and permanently using [27]. Compression garments are in contact to skin very closely with stretch ability to support blood flow and muscle systems. This situation causes discomfort for patients particularly in summer condition. Because of direct contact, there are only a few microclimates between skin and textile materials, so new structures with advanced comfort properties are needed to be used for compression garments.

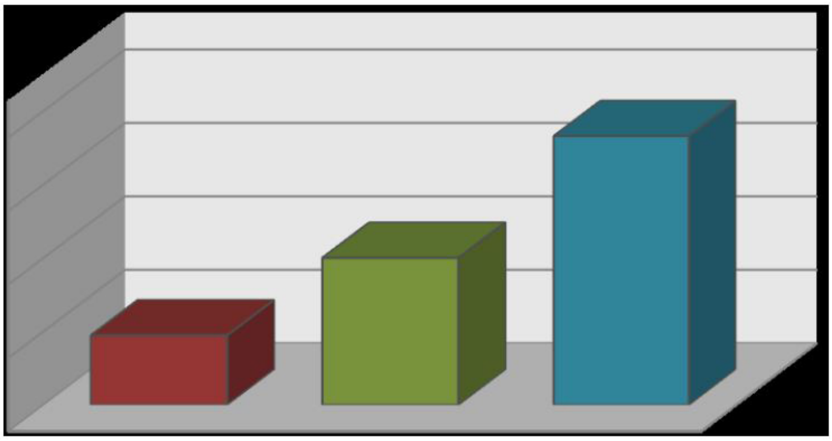
A comfortable textile product generally should not create excessive change on body temperature; efficiently remove the moisture and water vapour to the atmosphere and not cause irritation or allergies on skin [28]. Natural fibers are favoured raw materials for comfortable textile products with specialties such as breathability, high moisture absorbance, softness, non-allergenic and ecological structure. They are especially used in products which are in contact with skin just like underwear. Instead of synthetic fibers, using natural fibers increase day by day with the help of innovative trends in textile industry. New developed regenerated fibers provide the inspiration for outstanding products with their comfort and mechanical characteristics.

There are few studies about comfort characteristics of compression garments. Some of them examined the fiber characteristics of compression stocking and they indicated that using some different natural fiber or different fiber blend improved the comfort characteristics of stockings. In the study of Oğlakcıoğlu *et al.* investigated the effect of regenerated cellulose fibers on thermal comfort properties of compression stockings. The results showed that some of different special yarns such as viscose, modal or tencel could be recommended for summer stockings due to low thermal resistance, high water vapour and air permeability characteristics [29]. Bera *et al.* studied that the effect of varying the nylon and cotton blend percentage on comfort properties of pressure garments. According to results, the fiber blend percentage did not have any influence on air permeability and thermal property. However water vapour permeability and wicking behaviour affected significantly. Increasing in nylon percentage increased both of them [30].
A different study is about the air permeability, water transmission rate and thermal behaviour of pressure garments in extended condition to simulate the conditions during wear. This study revealed that the comfort properties changed significantly when fabric was held in an extended state. In this state the fabrics became thinner and this made the structure more permeable to air as well as water vapour [31]. Also in some other studies, the comfort characteristics of some special pressure garments using for hypertrophic burn scars were investigated. The new developed fabrics compared each other fabrics for comfort characteristics. Yıldız studied to generate a novel technique to determine pressure garments for hypertrophic burn scars and comfort properties. The thermo-physiological test results of this new composite fabric revealed that it had extremely low water vapour permeability and high resistance to evaporative heat loss. The water absorption percentage and absorption capacity were too low when compared control fabric which is a sportwool and single-jersey knitted [32]. Anand *et al.* investigated that the determination of the suitability of four fabrics to be utilized for management of hypertrophic scarring. The dimensional, mechanical and thermo-physiological properties of fabrics procured from different sources were compared. All fabrics also showed excellent water vapour permeability and extremely low resistance to evaporative heat loss from the skin to the environment [33].

Medical bandages are usually produced using polyamide covered elastane yarn as inlay yarn and polyamide filament yarn as ground yarn. Polyamide fiber is a suitable raw material with better mechanical properties and stretch ability but there are some disadvantages of this fiber such as soft touch and allergenicity. This study aims to improve comfort characteristics of medical compression bandages in addition to ecological effect, soft handle, and anti-allergic features. In the study, three elastane core yarns were produced using cotton, bamboo and tencel fibers as sheath and tubular medical bandages were knitted with these elastane core yarns as single jersey structure for wrist zone. Produced bandages were compared with commercially available polyamide tubular bandages in order to determine their sufficiency about pressure characteristics. Also the thermal resistance, water vapour and air permeability of these knitted fabrics were statistically analyzed.

The statistical results revealed that using different yarn type (cotton, bamboo and tencel) significantly changes thermal comfort parameters. On the other hand, pressure results proved that all fabrics were in the same pressure class (class II), since they were knitted on the same machine by the same production adjustments as seen in Table 2, with the same yarn properties (Table 1). The pressure and thermal comfort values and statistical differences for each yarn type are given in Tables 3. In this table, the mean values are marked with the letters 'a', 'b' and 'c'. Any levels marked by the same letter showed that there is not any significant difference between the fabric types.

Test results indicated that air permeability increase in cotton, bamboo and tencel fabrics, respectively, and tencel samples had the highest permeability within all samples (Figure 7). This result can be explained by lower hairiness and more compact structure of tencel yarn, as given in Figure 8, which provides higher fabric porosity and lower resistance to air penetration (Figure 9).



Air permeability Cotton Bamboo Tencel
**Figure 7:** Air permeability results for various types of fibres

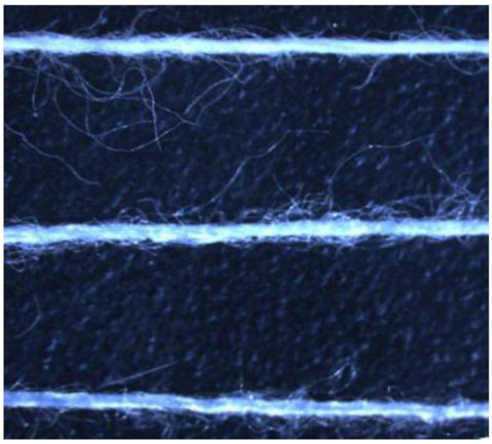
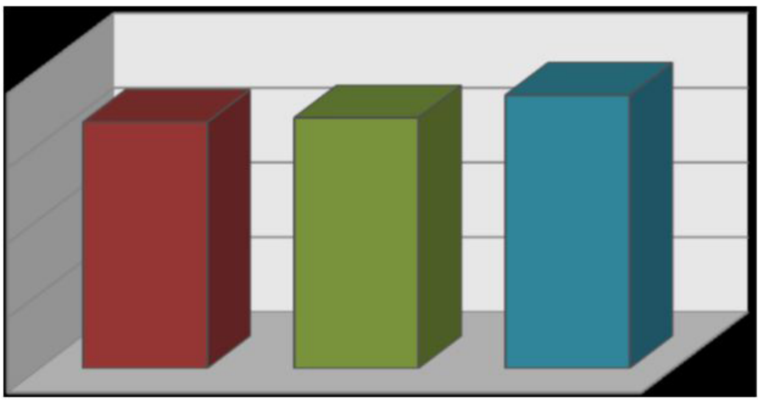


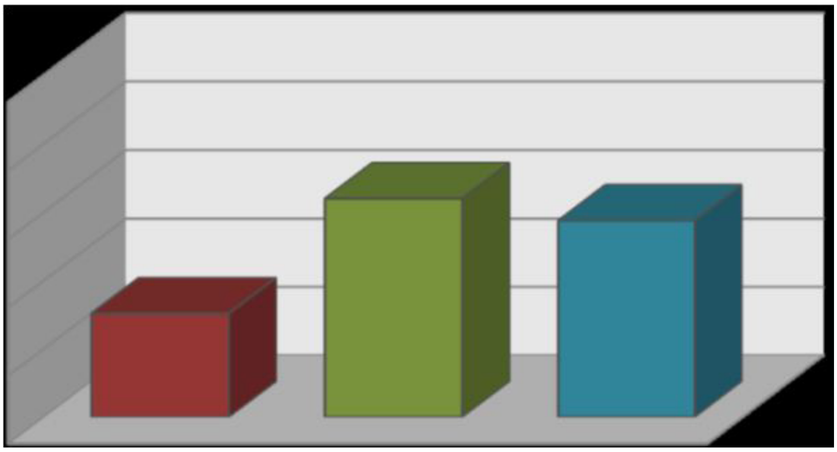
**Figure 8:**- Microscopic yarn images

All samples have water vapour permeability values over 30%, which is accepted as limit for comfortable feeling. Whereas Tencel fabric achieves the highest water vapour permeability values as similar to air transfer property.



Water vapour permeability Cotton Bamboo Tencel
**Figure 9:** Water vapour permeability of various fibre types

Test results indicated that air permeability increase in cotton, bamboo and tencel fabrics, respectively, and tencel samples had the highest permeability within all samples (Figure 7). This result can be explained by lower hairiness and more compact structure of tencel yarn, as given in Figure 8, which provides higher fabric porosity and lower resistance to air penetration (Figure 9).



Thermal resistance Cotton Bamboo Tencel
**Figure 10:** Thermal resistance of various fibre types

Medical bandages are strip or tube form of materials used to protect, immobilize, compress or support needed body parts and they are most common members of compression garments. They are usually produced using polyamide covered elastane as inlay yarn and polyamide filament as ground yarn. In this study, elastane core yarn with cotton, bamboo and tencel fibers as sheath were produced and tubular medical bandage samples were knitted with these yarns.

The key factors of compression therapy are the right pressure profile and permanently usage. Compression garments apply higher pressure than a casual garment to the skin. Because of this feature, a small area for microclimate effect occurs between skin and fabric. This situation causes comfort problems for patient especially in warm conditions such as hot climate or during a physical activity. This research presents a new perspective of using natural core-spun yarns for medical bandage as a novel technique. In previous studies, some special or natural fibers were integrated to the compression garments as ground yarn, but together with polyamide covered elastane yarns [37]. So these products showed a limited effect for comfort, because these fibers were not directly in contact with skin. In the scope of this study, the comfort properties of compression bandages are increased significantly with using natural fibers as sheath of elastic core spun yarns. According to the comfort test results, the developed samples show comparable properties than classical synthetic bandages. It is stated that tencel fibers are the most ideal raw material in summer days with higher air and water vapour permeability (Table 1).

| | **Control** | **Strip having standard Chitosan** | **Strip having chitosan extracted from prawn shell** |
|---|---|---|---|
| Number of Blood drops | 8 | 5 | 4 |
| blood clotting test Blood Coagulation time (in Seconds): Bleeding time = 30 × (number of blood drops) | | | |
| 1. For Control; Coagulation time = 30× 8 = 240 sec. | | | |
| 2. For standard chitosan; Coagulation time = 30×5 = 150 sec. | | | |
| 3. For Chitosan extracted from Prawn Shell; Coagulation time = 30×4 = 120 sec | | | |

**Table 1**

With this study, adequate pressure values were reached for compression therapy. The pressure results indicated that all knitted samples are in the same pressure class with commercially available polyamide bandages. It is proved that the compression garments at same pressure levels can be manufactured with suitable machine adjustments and elastane yarn counts even if different fiber types are used.

For further researches various core yarn types can be investigated for different aims such as burn treatment, leg ulcers. Because this technique enables to produce special compression garments with using elastane core yarn covered by different special fibers as raw material.

## Blood Clotting Time of Some Bandage Cloths

The quality of the bandage cloths is related to the blood clotting time. The lower the clotting time the better the bandage cloths. One recent study on chitosan based bandage cloths has shown the following results comparative study on different properties of Standard Chitosan and Chitosan extracted from Prawn Shell indicated that chitosan takes two fold less time to clot the blood than that taken by the natural blood clotting process. Also the chitosan extracted from prawn shell shows wound healing properties. It has shown significant healing effect on cut made on back, on application of bandages dipped into both standard & crude chitosan respectively It can be used effectively used in medical treatment to reduce blood loss and induce faster wound healing in case of heavy blood loss resulting from injury.

Chitosan extracted from the prawn shell can be used as active blood clotting agent. The Mechanical, Bioadhesive strength and Biological Evolutions of Chitosan films For Wound Dressing have been investigated. Chitin Nanofibre Reinforced Thin Chitosan Films have been used for Wound Healing Application. Hemostatic wound dressing have been developed. Artificial Skin (Template) has been developed and influence of different types of sterilization procedure on wound healing pattern in rabbits and guinea pigs have been studied.The results on the blood clotting and wound healing with crude extract of chitosan shows promising results (Figure 11).

Blood Clotting test:

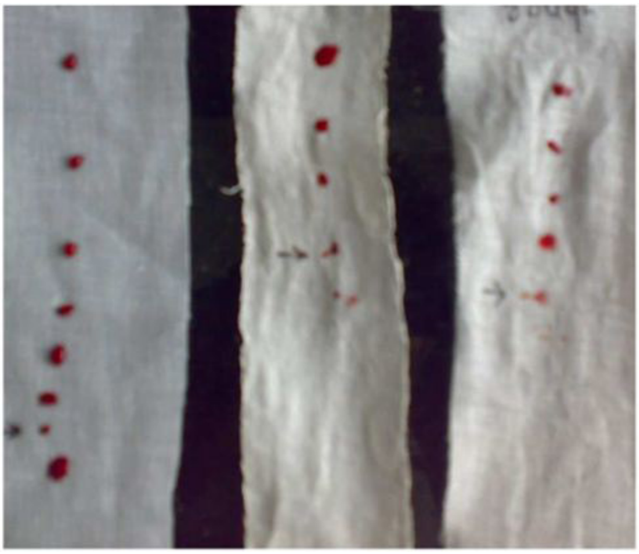


**Figure 11:** Control, standard chitosan and chitosan extracted from prawn shell

## Conclusion

Studies on cotton, bamboo, and bamboo cotton blend have clearly proved that the bandage finished with triclosan, an antimicrobial agent, gives better efficiency about 0.4 mm of zonal inhibition and also gives better resistance against microbes. The aloevera and vitamin E finish produces fragrance, cooling effect and also prevents the skin from getting scars.

Study has indicated that bamboo outscores cotton in a number of aspects such as antimicrobial activity, odour resistance, etc. Bamboo in inherently antimicrobial by nature.

In order to improve the functional properties of some orthesis and non-orthesis bandages of organs wounds, the gauze fabrics treated by different concentrations of honey and chitosan mixture (Chitoasllona, CA), other samples of gauze fabrics with treated honey and chitosan mixture flowed by modifier medical gypsum (Gybschitoasallona, GCA) for treatment orthopedic organs wound, the treated fabrics curred microwave radiation. then comparing it what is currently available in hospitals and pharmacies.

The results showed that when the concentration of honey and chitosan mixture increases the functional properties of the treated fabrics improved, namely, bactericidal activity. The finished fabrics were examined for morphological features and surface characteristics by making use of the SEM. Antibacterial activity of the treated and untreated fabric against *E. coli* (gram negative) and *Staphylococcus aureus* (gram positive) successfully examined. The results show modifier medical gypsum is deposited on the surface of fabric fibers and reduction of bacteria on the fabrics surfaces. The practice of this application proved fractures and wound healing speed for patients in the university hospital has increased by 12%, 17 % when using CA and GCA bandages with compared with the available presently bandages in hospitals and pharmacies. Tubular medical bandages were manufactured by using core spun yarns (sheath fibres are selected as tencel, bamboo and cotton, core material is elastane) and their pressure and comfort (air and water vapour permeability) characteristics were investigated. The results indicated that the bandages have good comfort abilities beside adequate pressure values for compression effect. These garments can constitute a new production field for medical bandages with their comfort properties in addition to pressure characteristics.

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