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Development of Natural Dyes for Non - Implantable Materials using Seaweeds for Medical Applications

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***Abstract*-- Seaweeds are rich source of structurally novel and active bioactive compounds. These bio active compounds are inhibited the growth of microorganisms present in human body. Seaweeds are classified into three different types such as Green, Brown & Red seaweeds based on those colours & pigment present in the colors of plants. The present study was to extract the dyes from five seaweeds such as ulva reticulata, ulva lactuca, Sargassum wightii, Padina tetrastomatica and Acanthophora spicifera. To investigate the presence of bioactive compounds and to explore the antioxidant and antimicrobial effect of the organic solvents such as acetone and aqueous extract on dye solutions and applied the dyes of green seaweed to the cotton fabric for making non implantable materials and investigated the presence of bioactive compounds, antioxidant and antimicrobial effect on the fabric.**

INTRODUCTION

Seaweed is a sea plant that is found in every sea or ocean and may belong to one of several groups of multi cellular algae. Seaweeds consist of three different groups based on thallus colours such as red, green and brown seaweeds. Seaweeds have been frequently used as an herbal medicine to suppress inflammation and also used for the treatment of various diseases such as allergy, cancer, ulcers, arthritis, and hypotension. Therefore, extracts of seaweeds, especially the brown and green seaweeds, could be utilized as a good natural source of a possible food supplement and is consumed as an anti-inflammatory agent in the pharmaceutical industry to treat some immunologic disorders and allergic diseases.

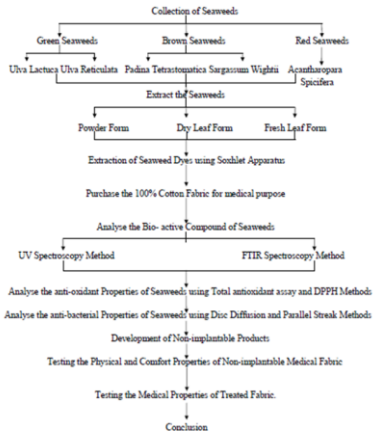
PROFILE OF SEAWEEDS

Seaweeds serve as important source of bioactive natural substances cultured in Indonesian waters, because its cultivation is relative easy and in expensive. It has a wide variety of colours from green to yellow green, grey, red and brown, indicating photosynthetic pigments, such as chlorophyll and carotenoids. An important factor in the effectiveness of pigment extraction is the choice of solvent. The correct type of solvent in the extraction method of specific natural materials is important for extracting a pigment with optimum quality that is also beneficial to the society can be produced. The target of this research is to obtain a high quality solvent type of carotenoids pigment.

COLLECTION OF SEAWEEDS

Fresh marine seaweeds Acanthophora Spicifera, Ulva Lactuca, Ulva Reticulata, Sargassum Wightii, and Padina Tetrastomatica were collected from Mandapam (Rameshwaram, Tamil Nadu) of South East coast of India. The collected samples were washed with tap water to remove epiphytes and other marine organisms and then washed with distilled water. Samples were dried at 45 °C and powdered

METHODOLOGY



COLLECTION OF SEAWEEDS

The sample is a known species of Sargassum Wightii, Ulva Lactuca, and Acanthophora Spicifera of edible brown, green, and red seaweed, which have good amount of nutrients, antioxidant and antibacterial activities. They were freshly obtained from thonidurai coast of mandapam and were rinsed

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in seawater and the packed in aseptic bags and brought to the laboratory for further processing.

EXTRACTION OF SEAWEEDS

The extraction of seaweeds is converted into powder Form, Dry leaf form, Fresh form of seaweed are used for the extraction of dyes. The conversion forms of seaweeds are used to extract crude dyes in powder and solution form by using Soxhlet apparatus.

Powder Form

The collected fresh Sargassum Wightii and Padina Tetrastomatica of brown algae, Ulva Lactuca and Ulva Reticulata of green algae, Acanthophora Spicifera of red algae were rinsed in fresh water to remove dirt and dust and they were bleached at 100ºc to remove impurities and salt. It was drained using sieve and shadow dried at room temperature for 3 days, further the dried species were shunted again for removal of excess salt and powder in blender. The cleaned and dried seaweeds are extracted by Soxhlet method. In this method, 20 g of powdered algal samples contained in a Whatmann No.1 filter paper thimble was placed into an extraction chamber. The extraction chamber was then connected to a flask containing 200 ml organic solvent such as acetone with increasing polarity. Constant heat source was supplied for this procedure (40-50°C). All the extracts were concentrated under reduced pressure using a rotary evaporator and left air dried in a fume cupboard to obtain paste extract. The dried paste extracts were then stored at 4°C for further bioassay.

PADINA TETRASTOMATICA

SARGASSUM WIGHTII

ULVA LATUCA

ULVA RETICULATA

SARGASSUM WIGHTII

Dry Leaf Form

The collected fresh Sargassum Wightii and Padina Tetrastomatica of brown algae, Ulva Lactuca and Ulva Reticulata of green algae, Acanthophora Spicifera of red algae were rinsed in fresh water to remove dirt and dust and they were bleached at 100ºc to remove impurities and salt. It was drained using sieve and shadow dried at room temperature for 3 days. The 5g of dry extract was taken in a Soxhlet apparatus for extraction of dyes.

ACANTHOPHORA SPECIFERA

PADINA TETRASTMATICA

ULVA LATUCA

ULVA RETICULATA

ACANTHOPHORA SPICIFERA

Fresh Plant Form

The collected fresh Sargassum Wightii and Padina Tetrastomatica of brown algae, Ulva Lactuca and Ulva Reticulata of green algae, Acanthophora Spicifera of red algae were rinsed in fresh water to remove dirt and dust and they were bleached at 100ºc to remove impurities and salt. The algae were cleaned using a brush to remove epiphytes with distilled water. After cleaning, to bags the polythene bags and stored at 4°c for further studies.

EXTRACTION OF SEAWEED DYES

The pigment extraction process begins by weighing 30 g. They were dissolved by organic solvent (Acetone) with a ratio of 1:5 (sea weed: Acetone), then stirred with a magnetic mixer for 3 hours, and continued the extraction had filtered using Whatman filter paper. This pigment filtrate results from concentrated filtration using a rotary vacuum evaporator at a temperature of 60-70 °C so that its volume is 1/8th of the initial volume.

SEAWEED DYES

The same procedure should be followed for all five types of seaweeds to extract the pigment content from thallus region and these extract are help to improve the medical properties to the textile materials.

SOXHLET EXTRACTION

The collected seaweeds of Padina Tetrastomatica, Sargassum Wightii and Ulva Lactuca, Ulva Reticulata and Acanthophora Spicifera powdered, dried and fresh samples were extracted (pigment extraction) by Soxhlet apparatus using 250 ml of acetone as solvent for 8h at 60°C. The extract was filtered by using Whatmann no.1 filter paper and kept it under hot air oven (40°C) for the solvent evaporation, and then 10 mg of extract was diluted with 10 ml of above mentioned solvents

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and the dye solution was closed in a air tight container for further process.

PROCURE OF COTTON FABRIC

A pure, 100% cotton fabric is the best fabric for medical application because of softer feel and good comfort to the skin. Almost every type of fabric available can be made with cotton fibers. The challenge is selecting the right fabric for the medical applications. Lightweight cottons are best for shirts, bed covers and masks and also medium-weight fabrics are suitable for

pants, skirts, shirts, dresses, curtains, sheets and children's clothes and also heavier type of fabrics are used for pants, outerwear, window treatments and work clothes.

ENZYME SCOURING

The fabric was immersed in the pectinase solution with 0.05M phosphate buffer at 55 C, M: L ratio of 1:50 for 1 hour. After treatment, the temperature was raised to 100°C for 10 min to stop the enzyme activity. The fabric was washed with hot water following by cold water and dried. Weight loss and sugar released from the fabric was estimated.

ENZYME BLEACHING

Cotton fabric was taken and placed in 0.1 M sodium phosphate buffer solution (pH 7.0). Add cellulase to it and mix well and incubate at 50°C for 3 hr. Inactivate the enzyme by boiling in water for 5 min. Wash the fabric thoroughly in tap water and then in distilled water, air dry for 1 hr.

EXHAUST METHOD OF DYEING

The method of dyeing is done by immersing the fabric material in the treatment bath containing the ulva Lactuca extract for 1 hour at 60°C. The fabric was removed from the bath and squeezed gently and air dried.

Soft Flow Dyeing Machine

In the soft flow dyeing machine water is used for keeping the fabric in circulation. The soft flow dyeing machines are suitable equipment for dyeing because of highly sophisticated temperate control and closed loop system for even dyeing process. In conventional jets that operates with a hydraulic system is that the fabric rope is kept circulating during the whole processing cycle (right from loading to unloading). There is no stopping of liquor or fabric circulation for usual drain and fill steps. The principle working behind the technique is very unique. There is a system for fresh water to enter the vessel via a heat exchanger to a special interchange zone. At the same time the contaminated liquor is allowed channel out through a drain without any sort of contact with the fabric or for that matter the new bath in the machine.

BIO-ACTIVE COMPOUND OF SEAWEEDS

The seaweeds has valuable compounds in its parts mainly in leaves portion .It has an excellent bioactive compounds such as polysaccharides, proteins, Polyphenols are used to protect the body as well as food substances. The flavonoids and Anthocyanin bioactive compounds are used for medical, health care and pharmaceutical activity. These compounds have been possesses to anti-viral, anti-tumor and anti-cancer properties. For the medical intention these bioactive compounds are very much intensive for diabetic and anti-allergic applications that are present in seaweeds.

QUANTITATIVE ANALYSIS OF BIO-ACTIVE COMPONENTS USING UV SPECTROSCOPY

The extract was centrifuged at 3000 rpm for 10 min and then filtered through Whatmann No.1 filter paper by using high pressure vacuum pump. The sample is diluted to 1:10 with the acetone solvent. The crude dye extracts containing the bioactive compound was analyzed spectroscopically for further confirmation. To detect the UV –VIS spectrum profile of the crude extracts of Acanthophora Spicifera, Sargassum Wightii, Padina Tetrastomatica, Ulva Lactuca and Ulva Reticulata dye extracts were scanned in the wavelength ranging from 400 – 800 nm by using Shimazdu Spectrophotometer coupled with detector and the characteristics peaks were detected. Peaks assignments were made by comparing the spectrum of sample with standard peaks for assessing the bio active compounds, chemical structure and bonds present in between the dye extracts from seaweeds.

QUANTITATIVE ANALYSIS OF BIO-ACTIVE COMPONENTS FOR FABRIC USING FTIR SPECTROSCOPY

FTIR analysis can be accomplished by Attenuated Total Reflectance (ATR), and thin film. Enough samples are required to obtain an absorption spectrum during FTIR analysis. Solid samples are usually prepared by shaving some material off of the sample that is thin enough to obtain a good spectrum.

The first step is to collect background spectra to subtract from the test spectra to ensure the actual sample is all that is analyzed. Next, the sample is analyzed by fully computerized Fourier Transform Infrared spectroscopy system which generates the absorbance spectra showing the unique chemical bonds and the molecular structure of the sample material. This profile is in the form of an absorption spectrum, which shows peaks representing components in higher concentration. Absorbance peaks on the spectrum indicate functional groups (e.g. alkanes, ketones, chlorides, flavonoids, Polyphenols, tannin and fucoidan). Different types of bonds, and thus different functional groups, absorb infrared radiation of different wavelengths. Although the analysis is performed in absorbance, it can be converted to transmittance, since they are simply the inversions of each other.

The analytical spectrum is then compared in a reference library program with cataloged spectra to identify components or to find a "best match" for unknown material using the cataloged spectra for known materials. The formations of bonds between the bioactive compounds are analyzed in FTIR spectroscopy for the treated fabrics. The peak present in the FTIR spectroscopy was confirmed the presence of bioactive compounds present in the treated fabric.

ASSESSMENT OF THE ANTIOXIDANT ACTIVITY

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Total Antioxidant Activity

The antioxidant activity of potential fraction from methanol extract was determined by phosphomolybdenum method. 5mg of seaweed fabric sample was mixed with 1 ml of acetone and made up to different concentration [20 – 100mg/ml] Were combined with reagent solutions (0.8 m sulfuric acid, 30 mm sodium phosphate and 6 mm ammonium molybdate) Separately. I n the case of blank, acetone was used in the place of sample. The tubes containing samples were capped and incubated in water bath at 95°c for 1hr. The absorbance was measured at 695 nm used a UV spectrometer against blank. The antioxidant activity was expressed as equivalent of standard ascorbic acid. All the sample are repeated thrice and measurement of activity are determined

QUANTITATIVE ASSESSMENT OF ANTIOXIDANT ACTIVITY

The diameter and intensity of the yellow spot depends on the amount of known amount and concentrations of the solutions. We can judge the potency of the test sample. Furthermore, reflectance values for each band can be calculated and photographs can be taken. 40 µg shows equal antioxidant property with that of 50 µg of rutin by this method. A method was developed to measure the radical scavenging activity of compounds separated by reversed phase TLC (RPTLC) using Phenolic acids as model analysis. TLC separation was followed by dipping the plate in a 0.04% (wt/vol) solution of 1,1-diphenyl-2- picrylhydrazyl (DPPH) in methanol. Reversed phase technique was applied for the measurement of free radical scavenging activity of seaweed fractions. Bleaching of β-carotene on TLC is another method. After developing and drying, plates were sprayed with a 0.02% solution of β-carotene in CH_2Cl_2. plates were placed under natural light until discoloration of background. The yellow spots remaining indicated the presence of antioxidant substances. Absorbance at 517 nm was determined after 30 min and the percentage of activity was calculated. Using TLC techniques of seaweeds were tested for their antibacterial, antifungal, acetyl cholinesterase inhibitory, antioxidant and radical scavenging activities. Antioxidant and radical scavenging activities were found to be predominant in highly polar extracts. The method was successfully applied to seaweed extract. A modified method combined with video scanning detection for quantitative evaluation of free radical scavenging activity of ant oxidative fractions from seaweed fabric by using DPPH is reported. The activity was evaluated by measuring the area of bright yellow bands against the purple background by a CCD video camera after dipping the plate in 0.04% (w/v) DPPH solution. DPPH scavenging activity of ascorbic acid and well-known Phenolic compounds including α-tocopherol, Phenolic acids and flavonoids were determined by this TLC-DPPH method.

DPPH RADICAL SCAVENGING ACTIVITY

Free radical scavenging activity was measured by 2, 2-Diphenyl-1-picrylhydrazyl (DPPH) according to the method of Yen and Chen (1995). Briefly, a 2.0 ml aliquot of test sample was added to 2.0 ml of 0.16 ml DPPH methanolic solution. The mixture was shaken vigorously then left to stand at room temperature for 30 min in darkness. Changes in the absorbance of the samples were measured at 517 nm using a spectrophotometer. The ability to scavenge the DPPH radical was calculated using the following equation:

$$\textbf{Scavenging effect (\%)} = 1-\frac{(A_{\text{sample}}-A_{\text{sample blank}})}{A_{\text{control}}}$$

Where:

A_{control} is the absorbance of the control (DPPH solution without sample),

A_{sample} is the absorbance of the test sample (DPPH solution plus test sample),

$A_{\text{sample blank}}$ is the absorbance of the sample only (sample without any DPPH solution). Ascorbic acid was used as a positive control.

ASSESSMENT OF ANTIBACTERIAL ACTIVITY

The AATCC plates were prepared by pouring 15ml of AATCC bacteria media into sterile Petri plates. The plates were allowed to solidify for 5min and the bacterial culture was inoculated as single line followed by the four lines without refilling the inoculation loop. The fabric was cut into 5×2.5 size and immersed in treatment bath containing herbal and antimicrobial agents with the M: L ratio of 1:10 for 15 minutes and air dried in at room temperature. The finished fabric with the diameter of 2.5 cm was placed over the inoculated bacterial species and the plates were kept for incubation at 37ºC for 24 hours. At the end of incubation, zone of inhibition formed around the fabric was measured in millimetre and recorded. The amount of antibacterial activity present in the fabric was determined.

DISC DIFFUSION METHOD FOR DYES

The antibacterial activity of dyes was evaluated with paper disc diffusion method. Briefly 6mm paper disks were impregnated with two different concentration 100 and 200 µl using methanol and aqueous extract of five samples of seaweed dyes and left dried on the disc. Then the discs were applied to the agar plates that were inoculated previously with the test organisms and incubated for 1 hr. The bacterial plates were incubated at 30°±4°c for 28 – 48 hr. Also chloramphenicol was used as positive control for two different concentrations (100 and 200 µg/disc). After incubation all plates were observed for zones of growth inhibition and the diameters of the zones were measured in millimetre. All tests were carried out in three times under sterile conditions.

PARALLEL STREAK METHOD

The parallel streak Method (AATCC 147-2004) has filled a need for a relative quickly and easily executed qualitative method to determine antibacterial activity of diffusible and non-diffusible antimicrobial agents on treated textile materials. In the classical “parallel streak Method (for diffusible agents) the agar surface is inoculated making it easier to distinguish between the test organism and contaminant organisms which may be present on the unsterile specimen. The parallel streak Method has been proven effective over a number of years of use in providing evidence of antibacterial activity against both Gram positive and Gram negative bacteria. A modified parallel streak Method can be used to evaluate the antimicrobial

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activity of non-diffusible agents. There by a piece of textile is pressed onto an agar plate and the test bacteria are inoculated over the specimen by three or four parallel streaks.

FABRIC CHARACTERISTICS

Comfort characteristics of fabric are essential for medical products. The following properties was tested for Physical and comfort characteristics of the medical fabrics.

Air Permeability Test

Air permeability is essential for the medical textiles and the amount of seaweed trap in the interstices of yarn will give the amount of air passed between the treated and untreated fabrics. The amounts of air passes per square cm of the fabric will depend on the fabric characteristics and its end use. The changes in climatic condition are necessary for the use of different type of fabrics. The fabric should retain only the dust and it should leave the clean air to the surroundings. All these things are possible with the construction of fabric. In order to test fabric and its relationship to air, we must understand the definition of some of the common terms connected with it. The most common terms is used in air Permeability is as follows.

If the term permeability is considered, two types of permeability are of most important for fabric.

1. Permeability to air - This is desirable in clothing, but undesirable in over coating, sailcloth, balloon cloth and medical fabrics.
2. Permeability to water vapour - This is desirable in clothing especially in under wear, but undesirable in materials used for coverings such as tarpaulins.

Bending Rigidity Test

Bending rigidity property is very important for wearable and medical wear. It also means that flexibility of fabric. Cut the fabric sample of 6” length and 2 ½” width. The treated and untreated fabric was placed on the surface plate of stiffness tester at origin point. Then place the bending length scale on the fabric and move forward slowly. After reach certain length, the end of fabric will fell down for its own weight, move until the tip of fabric coincide the status line.

Then note it down the measurement shown in the graduation scale. It is the bending length of sample. Similarly take several test as per above procedure for both warp and weft direction of fabric. Finally calculate the average bending length value, and then put it in the formula for calculating the flexural rigidity and bending modulus of the treated and untreated fabric.

Crease Recovery Test

Crease recovery property is very important for non-implantable materials. By using templates, the given fabric is cut to a size of 2”x1”. Five warp way and five weft way sample are cut the treated and untreated fabric. The longer side of the specimen is parallel to warp or weft threads respectively.

1. The instrument is levelled with the help of the levelling screws and knob level
2. The specimen is folded gently end to end with its edges in one line, with the help of the tweezers.
3. The edges should not be gripped more than 5mm in the tweezers.
4. The folded specimen is placed on the lower plate of the loading device and the load is applied gently according to ASTM standards.
5. Before loading, a metal foil with thickness not more than 0.02 mm is placed between the limbs of the specimen.
6. After 5 minutes the load is removed.
7. Five test specimens for both warp and weft should be folded face and the other five specimens back to back.

Rubbing Fastness Tes

Colour fastness to rubbing is very important for non-implantable materials in both dry and wet rubbing. It is equipped with timer, crank web, stainless steel sample clamp and 16mm (diameter) measuring head. For rubbing fastness tester of cotton and blended coloured fabrics and leather dyeing, are tested according AATCC (08) standard test. The materials are rubbed for 110 revolutions for both dry and wet samples. The rubbed specimens are compared with grey scale according to AATCC and ISO standard. The rubbed specimen is rated on the scale range from 1to5.

Spray Test

Water absorbency is one of the important properties for determining the comfort characteristics of non-implantable materials for medical applications. We have analyzed the water absorbency of the treated medical fabric. The result is possible for making products in medical fields. In this test, we take the funnel and holding stand for drop test. Initially fill the distilled water in the conical flask and hold the fabric by frame. Place the fabric under the funnel, and drop the water. Maintain the water droplet as single drop to the fabric. After fell down the single water drop immediately watch, how long it can be spread. Note it carefully until the water spherical shape fully flattened on the fabric. Similarly take several tests at various place of the fabric. Finally, calculate the average time for water absorbed on the fabric surface.

Tensile Strength Test

Tensile strength property is very important for non-implantable materials. By using templates, the given fabric is cut to a size of 12”x2”using strip method. Five warp way and five weft way sample are cut for strip test. Effective specimen length in between the jaws will be 8”. Inspect the tester for the proper size of the jaws, distance between the jaws, and any other setting that are necessary.

1. Place the cut strip sample in the jaws. The specimen should be so placed that years are broken perpendicular to the load.
2. The initial position of the elongation pointer is noted.
3. The instrument switched “ON”. The bottom jaw lowers and pulls the Specimen. The force is applied on the fabric elongates and finally breaks.
4. When the sample breaks, the breaking strength is noted and recorded by seeing the pointer position of the appropriate selected scale.
5. Now the position of the pointer on the elongation scale is noted. From the initial length, the Elongation in mm was found out.

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6. The movement of the lower jaw is now traversed by pressing the reverse push button provided in the instrument. So the pendulum and bottom jaw return to the original positions and the tensile strength in kgf of the treated and untreated fabric was automatically transferred to the system.

Tearing Strength Test

Tearing strength property is very important for non-implantable materials. By using templates, the given fabric is cut in both warp and weft ways with the size of 63 mm x 100 mm are prepared with the help of the knife cutter. The five samples in both warp and weft direction are cut lengthwise direction parallel to the fabrics in which the tearing strength is determined. The cutting knife is used to cut the specimens of width 63 mm. The length of the specimen is manually cut to a length of 100 mm by using a scissor. The specimens are then conditioned and tested in the standard testing atmosphere.

1. Calibrate the instrument for initial adjustments.
2. The capacity of the instrument is selected. so that the specimen tears between 20 and 60 percent of the scale value.
3. Five warp way and five weft way fabric specimens are cut by using the cutting knife and scissor.
4. The pendulum is raised to the starting position and the pointer is set against its stop.
5. The conditioned test specimen is fixed in between the two clamps so that it is well centered, with bottom edge set against the marks and the upper edge parallel to the top of the clamps.
6. A 20 mm slit is cut in the specimen by using the template present in the instrument.
7. The pendulum is then released by depressing the pendulum stop. The stop is held down until after the tear is completed and the pendulum is caught on the return swing by the operator's hand without disturbing the position of the pointer.
8. The position of the pointer on the scale is noted.
9. If the specimen slips in the jaw or if the rear deviates more than 6 mm away from the projection of the original slits the readings are rejected.
10. The above procedure is repeated for all the test specimens and the average tearing force in kgf was calculated for the warp and weft way test specimens.

Washing Fastness Test

Washing fastness test is an important property in the performance of medical fabric and it is used to provide an indication of the removal of dyes and reduction of anti-bacterial activity present on the surface of the fabric. In the test, change in color of the textile and also staining of colour on the adjacent fabric are assessed. A 10 x 4 cm swatch of the colored fabric is taken and is sandwiched between two adjacent fabrics and stitched with standard stitch per inch. The sample and the adjacent fabric are washed together. Five different types of washing are specified as different washing methods. The solution for washing should be prepared to the required temperature of washing. The liquor to Material ratio is 50:1. After soaping treatment, remove the specimen, rinse twice in cold water and then in running cold water under a tap. Squeeze it and air dry at a temperature not exceeding 60°C. The change in colour and staining is evaluated with the help of grey scales.

WASHING FASTNESS TEST

Wicking Test

Textiles serve as both a barrier and a transporter of heat, air and moisture from one environment to another. In the case of medical fabrics the amount of water absorbed on the fabric act as a boundary between the micro environments immediately surrounding the body and the outer environment. The development and innovation of various man-made fibres are to simulate the use of cotton in medical applications. The fabrics were treated with seaweeds are cut in the form strip and placed in the pipette stand and sink the fabric edges on the surface of the conical flask containing dye solution and measured the absorbance time and length of the treated and untreated fabrics. These results was determined the amount of absorbance of water in the treated and untreated fabric. The fabrics finished with natural plants, dyed and enzyme treated fabrics were tested for the Wick ability test.

MEDICAL TEST

Anti-Allergy Test

The fabric patched on the normal skin was observed for the specified period of time for the development of the symptoms related to contact dermatitis allergy. Non hairy part of the skin of the subjects was selected. The surface of the skin was cleaned with moistened sterile cotton swabs. The patches of the fabric sample were made and plastered on the surface of the cleaned skin. The site of patching was observed for any immediate allergic response. Observations were made up to 24 hours for the symptoms such as Skin rashes, redness and irritations. The time of observation may be extended for another 24 hours to confirm the effect.

RESULTS AND DISCUSSION

Bio-Active Component of Seaweeds

The seaweeds have valuable compounds in its parts mainly in leaves portion. It has an excellent bioactive compound such as polysaccharides, proteins, Polyphenols etc are used to protect the body as well as food, these flavonoids and anthocyanin bioactive compounds are used for medical, health and pharmaceutical industry. These compounds have been possesses to antiviral, antitumor and anti-cancer properties.

QUALITATIVE ASSESSMENT OF BIO-ACTIVE COMPONENTS OF DYES USING UV SPECTROSCOPY

The qualitative UV-VIS fingerprint profile acetone extract of Acanthophora Spicefera (Fig.1) was picked a wavelength from 200 to 800 nm due to the sharpness of the peaks and proper baseline. The profile showed the peaks at the 200 to 800 nm due to the sharpness of the peaks and proper baseline. The

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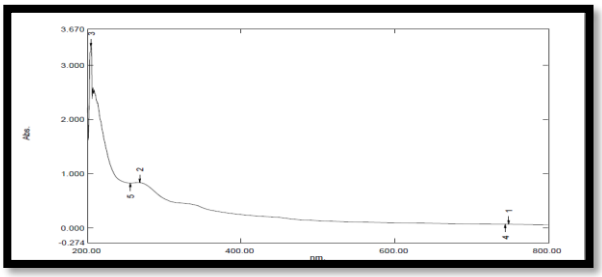
profile showed the peaks at the mm of 256, 204,267,744 and 749 with the absorption 0.824, 0.834 and 3.342 respectively. The qualitative UV-VIS fingerprint profile of Sargassum Wightii with acetone extract was selected at the wave length from 200mm to 800mm due to the sharpness of the peak and proper baseline. The profile showed the peaks at the nm of 294, 386,642 and 660 with the absorption of 0.741, 3.004, and 1.580. The qualitative UV-VIS fingerprint profile of Padina Tetrastomatica with acetone extract was selected at the wave length from 200mm to 800mm due to the sharpness of the peak and proper baseline. The profile showed the peaks at the nm of 244, 212 and 265 with the absorption of 1.747, 1.703, and 2.142. The qualitative UV-VIS fingerprint profile of Ulva Lactuca with acetone extract was selected at the wave length from 200mm to 800mm due to the sharpness of the peak and proper baseline. The profile showed the peaks at the nm of 256, 328 and 336 with the absorption of 1.486, 1.542, and 3.354.

The qualitative UV-VIS fingerprint profile of Ulva Reticulata with acetone extract was selected at the wave length from 200mm to 800mm due to the sharpness of the peak and proper baseline. The profile showed the peaks at the nm of 242 and 266 with the absorption of 1.286 and 1.171.

UV-visible spectroscopic identification was conducted and compared with standard to confirm the identity of the purified compound in this regard. The UV-visible spectrum of the purified compound was recorded and its absorption maximum (λmax) was compared with the standard. The results confirmed that the presence of bioactive compounds are responsible for increasing the anti oxidant properties of dyes.

Spectrum Peak Report
Data Set: Acanthophora Spicifera – Raw Data

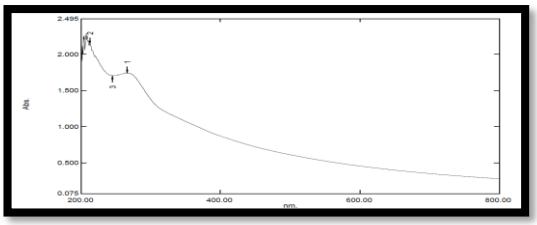


UV SPECTROSCOPY BEAK VALUE OF ACANTHOPHORA SPICEFERA

No.	P/V	Wavelength	Abs.	Description
1	↑	749.00	0.064	
2	↑	267.50	0.834	
3	↑	204.50	3.342	
4	↓	744.50	0.062	
5	↓	256.00	0.824	

UV SPECTROSCOPY WAVELENGTH OF ACANTHOPHORA SPICEFERA

Spectrum Peak Report
Data Set: Padina Tetrastomatica – Raw Data

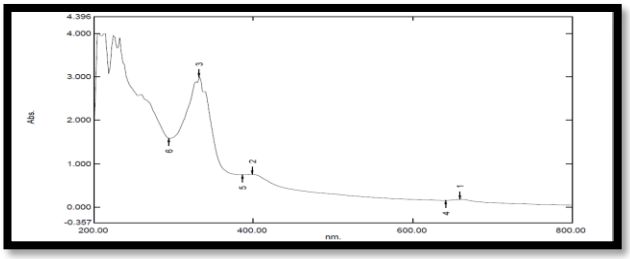


UV SPECTROSCOPY BEAK VALUE OF PADINA TETRASTOMATICA

No.	P/V	Wavelength	Abs.	Description
1	↑	265.50	1.747	
2	↑	212.50	2.142	
3	↓	244.50	1.703	

UV SPECTROSCOPY WAVELENGTH OF PADINA TETRASTOMATICA

Spectrum Peak Report
Data set: Sargassum Wightii– Raw Data

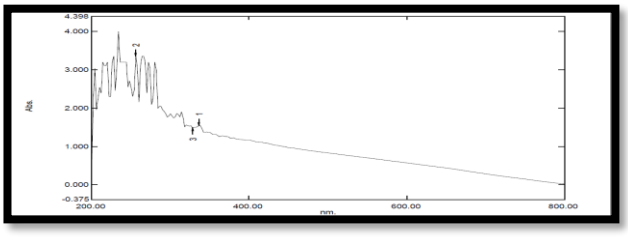


UV SPECTROSCOPY BEAK VALUE OF SARGASSUM WIGHTII

UV SPECTROSCOPY WAVELENGTH OF SARGASSUM WIGHTII

No.	P/V	Wavelength	Abs.	Description
1	↑	660.00	0.173	
2	↑	398.00	0.754	
3	↑	332.00	3.004	
4	↓	642.00	0.150	
5	↓	386.00	0.741	
6	↓	294.00	1.580	

Spectrum Peak Report
Data set: Ulva Lactuca – Raw Data



UV SPECTROSCOPY BEAK VALUE OF ULVA LACTUCA

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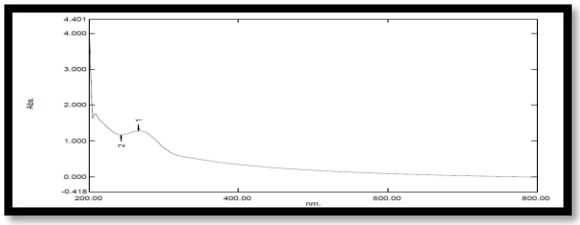
No.	P/V	Wavelength	Abs.	Description
1	↑	336.00	1.542	
2	↑	256.00	3.354	
3	↓	328.00	1.486	

UV SPECTROSCOPY WAVELENGTH OF ULVA LACTUCA

Spectrum Peak Report
Data Set: Ulva Reticulata – Raw Data



UV SPECTROSCOPY BEAK VALUE OF ULVA RETICULATA

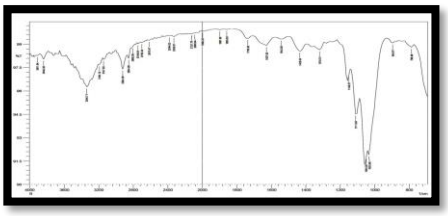
UV SPECTROSCOPY WAVELENGTH OF ULVA RETICULATA

No.	P/V	Wavelength	Abs.	Description
1	↑	266.00	1.286	
2	↓	242.00	1.171	

QUALITATIVE ASSESSMENT OF BIOACTIVE COMPONENTS OF FABRIC USING FTIR SPECTROSCOPY

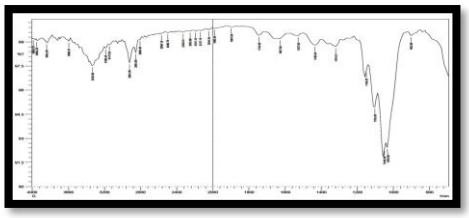
The FTIR spectrum was used to identify the bio active groups present in the seaweed treated fabric based on the peak value in the region of infrared spectrum. The sample of treated fabric was passed in to the FTIR. The downward peak present in the spectrum was confirmed the presence of functional groups such as flavonoids, amides, phenols, Tannin and xanthophylls compounds present in the treated fabric. The result of FTIR analysis was showed at maximum peaks at 1049.28 and 1033.85 respectively was confirmed the presence of bioactive compounds present in the treated fabric.

FTIR Test on Brown Seaweed



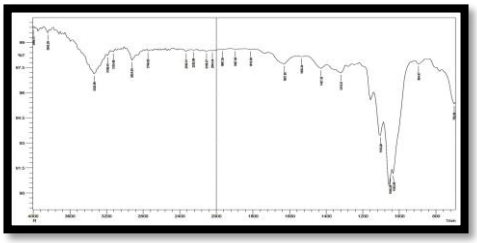
FTIR SPECTROSCOPY BEAK VALUE OF SARGASSUM WIGHTII

FTIR Test on Green Seaweed



FTIR SPECTROSCOPY BEAK VALUE OF ULVA LACTUCA

FTIR Test on Red Seaweed



FTIR SPECTROSCOPY BEAK VALUE OF ACANTHOPHORA SPICEFERA

EXTRACTION OF SEAWEED DYES

Natural dyes from seaweeds have huge demand not only in textiles industry, but also in medical, food, cosmetics, leather and pharmaceuticals. The dye extract from thallus of five types of seaweeds has good coloration to textiles and exhibit excellent medicinal properties. The colour produced from seaweeds has excellent anti-oxidant and antibacterial properties, but the amounts of shade produced from seaweeds are less and has a great potential in textile coloration.

SOXHLET EXTRACTION

The pigment extraction process begins by weighing 30g. They were destroyed by organic solvent (Acetone) with a ratio of 1:5 (sea weed: Acetone), then stirred with a magnetic mixer for 3 hours, and to continue the extraction had filtered using Whatmann filter paper. This pigment filtrate results from concentrated filtration using a rotary vacuum evaporator at a temperature of 60-70 °C. The $1/8^{th}$ of the initial volume of dyes in solution form are used for application of cotton fabric for medical textiles.

FABRIC PARAMETERS

Cotton fibre differs markedly from others cellulose fibre in morphological structure due to many salient features such as softer feel, durability and comfort to the wear. These properties are most useful for medical fields.

The salient features of cotton fabrics are as follows:

1. Cotton fabrics have good durability and are inferior to synthetic fabrics.
2. Cotton fabric is a chemically stable material, it says undamaged even under the continuous exposure of week acids and alkalis.
3. Cotton fabrics are used for even dyeing, because of good moisture absorbency and comfort to the wearer.

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Fabric Parameters

S. No	Parameters	Cotton fabric
1.	Structures	Plain
2.	Picks Per Inch	86
3.	Ends Per Inch	88
4.	Yarn Count	40Ne
5.	GSM	130

Assessment of Antioxidant activity

The antioxidant activity of Ulva Lactuca was measured by using total antioxidant assay and DPPH method. The result shows that the antioxidant activity increases with increasing the concentration of the fabric sample.

Total Anti-Oxidant Activity of Fabric Sample

The total antioxidant activity of ulva Lactuca was measured the antioxidant activity increases with increasing concentration of the fabric sample. The higher antioxidant activity occurs at 100 mg/ml as compared with standard ascorbic acid with the equivalent concentrations between 60 – 80 mg/ml. The seaweeds are rich source of antioxidants. This antioxidant plays a complimentary role by preventing the oxidation of cellular oxidize on the skin substrates and inhibiting reactive oxygen species for humans.

TOTAL ANTIOXIDANT ACTIVITY OF FABRIC SAMPLE

S. No.	Concentration (µg/ml)	Total Antioxidant activity [Absorbance at 695 nm]	
		Standard	Treated fabric
1.	20	0.21	0.18
2.	40	0.30	0.27
3.	60	0.40	0.38
4.	80	0.45	0.40
5.	100	0.56	0.51

DPPH RADIAL SCAVENGING ACTIVITY

a) Seaweeds

The antioxidant property of Ulva Lactuca, Acanthophora spicefera, Ulva Reticulata, Sargassum Wightii, and Padina Tetrastomatica was analyzed by DPPH radical scavenging method. This property based on the percentage of scavenging activity present in types of seaweeds.

ANTIOXIDANT ACTIVITY OF THE METHANOL EXTRACT

S. No	Seaweeds Name	DPPH Free Radical Scavenging Activity % Inhibition	
		Methanol	Aqueous Extract
1.	Sargassum Wightii	86.04 ± 3.21	87.11 ± 1.65
2.	Padina Tetrastomatica	85.20 ± 1.41	42.17 ± 2.19
3.	Ulva Lactuca	86.48 ± 2.84	89.30 ±1.54
4.	Ulva Reticulata	63.58 ± 1.74	65.14 ± 1.24
5.	Acanthophora spicefera	82.18 ± 1.39	24.85 ± 2.87

The results indicate that the percentage of radical scavenging activity increases, with increase the concentration of methanol extract and aqueous extract. As per the result the antioxidant property of the green seaweed is better than other brown and red seaweeds. The antioxidant activity will help to reduce the amount of free radicals in oxygen species and fast growth of cell membrane present in the skin.

b) Treated Fabric

The radial scavenging activity of treated fabric was analysed by DPPH method. The method helps to assess the % of scavenging activity present in the treated fabric. The test results are shown below.

Antioxidant Activity of the Methanol Extract of the Treated Fabric

S. No	Treated fabric	DPPH Free Radical Scavenging Activity % Inhibition	
		Methanol	Aqueous Extract
1.	Ulva Lactuca	86.48 ± 2.84	89.30 ±1.54

The test results of the treated fabric shows that the percentage of radical scavenging activity was same for seaweed extraction dyes and treated fabric. The antioxidant activity was more important for medical fabric, because of trapping the free radial of oxygen species and inhibits the cell damage and develops the cell growth present in the skin.

Assessment of Antibacterial Activity

The antibacterial activities are tested on the standard of AATCC 147 for treated fabric. It was determined mainly by two bacterial species such as Staphylococcus aureus and Escherichia coli. The both samples are taken in the size in the range of1.5 x 108 cfc/ml. In this two bacterial species, Escherichia coli had an excellent antibacterial activity when compared to staphylococcus aureus. These anti-bacterial properties are more important for curing degenerative diseases in healthcare and hygienic textiles.

Disc Diffusion Method for Dyes

The antibacterial activity of dyes was evaluated with paper disc diffusion method. Briefly 6mm paper disks were impregnated with 100 and 200 µg /ml of five samples of seaweed dyes and dry it for several hours. Then the discs were applied to the agar plates that were inoculated previously with the test organisms and incubated for 1 hr. The bacterial plates were incubated at 30°±4°c for 28 – 48 hr. Also chloramphenicol was used as positive control (100 and 200 µg/disc). After incubation all plates were observed for zones of inhibition and the diameters of the zones were measured in millimetres. All tests were carried out in three times under sterile conditions. The result shows that maximum

zone of inhibition occurs at 200 µg /ml for both pathogenic bacteria on dyes. These properties will inhibit the growth of bacteria to the maximum extent and it is more useful for medical fields.

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DISC DIFFUSION METHOD OF DYES

S. No	Seaweeds	Extraction	Concentration (µg/ml)	Staphylococcus Aureus	Escherichia Coli
1.	Sargassum Wightii	Methanol	100	19 ± 2.7	20 ± 2.3
			200	32 ± 2.6	34 ± 3.7
2.	Ulva Lactuca	Methanol	100	19 + 2.7	18 + 2.7
			200	32 + 1.6	27 + 2.5
3.	Acanthophora Spicifera	Methanol	100	17 ± 3.9	13 ± 1.3
			200	28 ± 1.5	23 ± 2.6
4.	Padina Tetrastomatica	Methanol	100	22 ± 2.6	27 ± 1.6
			200	27 ± 2.9	32 ± 3.9
5.	Ulva Reticulata	Methanol	100	19 ± 29	19 ± 2.8
			200	30 ± 1.8	26 ± 2.3

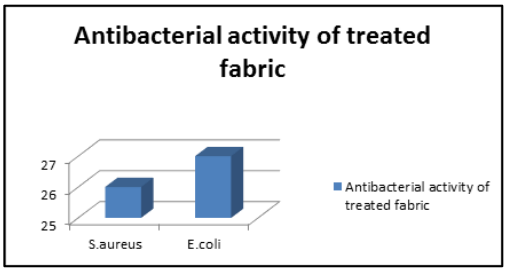
Parallel Streak Method for Treated Fabric

The AATCC plates were prepared by pouring 15 ml of media into sterile Petri plates. The plates were allowed to solidify for 5min and the test bacterial culture **(**Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa) was inoculated as single line followed by the four lines without refilling the inoculation loop. The treated fabric was cut into 5×2.5cm size and placed over the inoculated test bacterial cultures, separately. The plates were kept for incubation at 37ºC for 24h. At the end of incubation, zone of inhibition formed around the fabric was measured in millimetre and recorded.

ANTIBACTERIAL ASSESSMENT BY AATCC 147

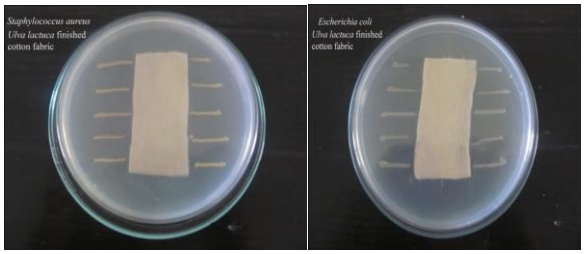
S.No	Fabric Sample	Seaweed Sample	Zone of Inhibition (mm)	
			Staphylococcus Aureus	Escherichia Coli
1.	100% Cotton	Green seaweed (Ulva Lactuca)	26	27

This treated fabric has a property to inhibit the growth of bacteria to a maximum extent and this fabric is most widely used for curing degenerative diseases.



ANTIBACTERIAL ACTIVITY OF TREATED FABRIC

The graph shows that the antimicrobial properties of the selected sample of ulva Lactuca had an excellent antibacterial activity for human pathogenic bacteria such as staphylococcus aureus and Escherichia coli.



STAPHYLOCOCCUS AUREUS ESCHERICHIA COLI

The above figure shows that the zone of inhibition is clearly seen on the sides of the treated fabric against Staphylococcus aureus and Escherichia coli.

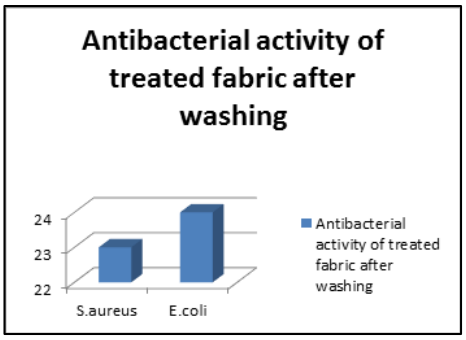
Parallel Streak Method in Treated Fabric for after Washing

The table shows that after repeated washing cycle of more than 10 times the treated fabric had an excellent antibacterial activity. The detergents present in washing will not affect the treated fabric. Therefore seaweed dyes are evenly applied on the interstices of the fabrics and the affinity against detergents is lower and better inhibition against pathogenic bacteria for medical fabrics.

ANTIBACTERIAL ASSESSMENT AFTER WASHING BY AATCC 147

S.No	Fabric Sample	Seaweed Sample	Zone of Inhibition (mm)	
			Staphylococcus Aureus	Escherichia Coli
1.	100% Cotton	Green seaweed (Ulva Lactuca)	23	24

This treated fabric after washing has a property to inhibit the growth of bacteria to a maximum extent and better zone after repeated washing.



ANTIBACTERIAL ACTIVITY OF TREATED FABRIC AFTER WASHING

The graph shows that the antimicrobial property was not affected even after repeated washing against gram positive and gram negative bacteria.

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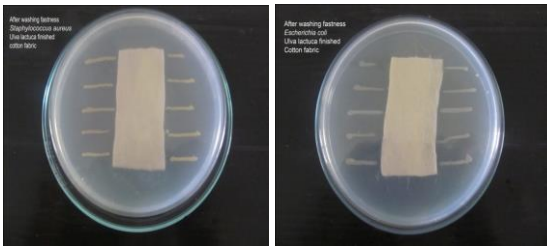


STAPHYLOCOCCUS AUREUS ESCHERICHIA COLI

FABRIC CHARACTERISTICS

Analysis the Air Permeability Properties

Air permeability is an important factor in the performance of treated materials and it is used to provide an indication of the breathability of fabrics. Cotton fabric basically plain weave structure, so that the air can easily pass the air through the fabric to the surrounding and the amount of air passes through sq/cm of fabric would result in permeable characteristics of the fabric.

Significant difference between treated and untreated fabric

AIR PERMEABILITY TEST

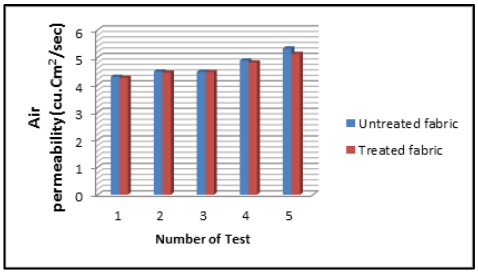
S. No	Untreated fabric	Treated fabric
1	4.29	4.25
2	4.48	4.44
3	4.47	4.46
4	4.88	4.81
5	5.32	5.12

The statistical tools used for verifying the significance difference between the treated and untreated samples was ANOVA tools. In our project, we can use one way ANOVA with two variables are used for testing the significance difference between the samples.

ANOVA TABLE FOR AIR PERMEABILITY

ANOVA: Single Factor	α	0.05				
SUMMARY						
Groups	Count	Sum	Average	Variance		
Untreated	5	22.01	4.402	0.07567		
Treated	5	23.04	4.608	0.11687		
ANOVA						
Source of Variation	SS	Df	MS	F	P-Value	F critical
Between Groups	0.10609	1	0.10609	1.102005	0.325	5.317655
Within Groups	0.77016	8	0.09627			
Total	0.87625	9				

Result: F value is smaller than the F critical. Therefore null hypothesis is accepted. This shows that no significant difference arises in the treated and untreated fabric after dyed with seaweed.



AIR PERMEABILITY

The result shows that the treated fabric had an effect of reducing the amount of air passes through the interstices of the fabric. There is no significant difference in amount of air passes per square cm of the treated and untreated fabrics.
The air permeability is defined as the amount of air pass through 1sq.cm of the fabric in seconds. The above figure shows that cover factor of the fabric increases with increases in air permeability for the untreated fabric, but in case of treated fabric due to the dye no leaves absorbed on the interstices between the yarns present in the fabric therefore the air permeability is slightly decreased.

Analysis the Bending Length Properties

Fabric bending properties indicates the resistance of the fabric to bending and it is a key factor for the study of handle and drape. This test works on the principle of cantilever. This method is used to determine the bending length, flexural rigidity and bending modulus of the treated and untreated fabrics.

Significant difference between treated and untreated fabrics

BENDING LENGTH TEST

S. No	Untreated fabric (cm)		Treated Fabric (cm)	
	Warp	Weft	Warp	Weft
1.	3	2.8	2.9	2.7
2.	2.8	2.6	2.8	2.6
3.	3.1	2.9	3	2.8
4.	3.1	2.9	2.9	2.6
5.	2.9	2.7	2.8	2.5

The statistical tools used for verifying the significance difference between the treated and untreated samples was ANOVA tools. In our project, we can use one way ANOVA with two variables are used for testing the significance difference between the samples.

ANOVA TABLE FOR WARP WAY BENDING LENGTH

ANOVA: Single Factor		α	0.05				
SUMMARY							
Groups		Count	Sum	Average	Variance		
Untreated	Warp	5	14.9	2.98	0.017		
Treated	Warp	5	14.4	2.88	0.007		
ANOVA							
Source of Variation		SS	Df	MS	F	P-Value	F critical
Between Groups		0.025	1	0.025	2.083333	0.187	5.317655
Within Groups		0.096	8	0.012			
Total		0.121	9				

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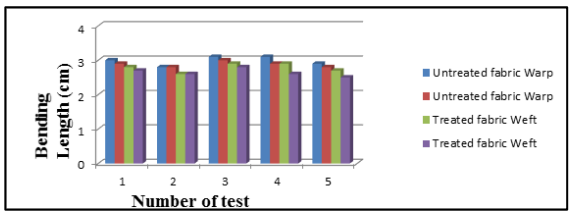
ANOVA TABLE FOR WEFT WAY BENDING LENGTH

ANOVA: Single Factor		α	0.05				
SUMMARY							
Groups		Count	Sum	Average	Variance		
Untreated	Weft	5	13.9	2.78	0.007		
Treated	Weft	5	13.2	2.64	0.013		
ANOVA							
Source of Variation		SS	Df	MS	F	P-Value	F critical
Between Groups		0.049	1	0.049	3.266667	0.108	5.317655
Within Groups		0.12	8	0.015			
Total		0.169	9				

Result: F value is lesser than the F critical. Therefore null hypothesis is accepted. This shows that no significant difference arises in the treated and untreated fabric after dyed with seaweed.



Bending Length

The result shows that the treated fabric had an effect of resistance to bending after dyed with seaweeds. There is no significant difference between the treated and untreated sample, because of even dyeing take place in the interstices of the yarn present in the fabric was not affect the stiffness of the treated fabric.

Analysis the Bending Modulus Properties

The result shows the correlation between the flexibility and elongation of the treated fabric had an effect of resistance to bending after dyed with seaweeds. There is no significant difference between the treated and untreated sample because of flexible property does not affect the stiffness of the treated fabric.

Significant Difference between Treated and Untreated Fabrics

BENDING MODULUS TEST

S. No	Untreated fabric (kg/cm^2)		Treated fabric (kg/cm^2)	
	Warp	Weft	Warp	Weft
1.	0.00414	0.00239	0.00356	0.00283
2.	0.00336	0.00211	0.00283	0.00253
3.	0.00434	0.00269	0.00387	0.00316
4.	0.00456	0.00211	0.00393	0.00250
5.	0.00373	0.00273	0.00335	0.00253

The statistical tools used for verifying the significance difference between the treated and untreated samples was ANOVA tools. In our project, we can use one way ANOVA with two variables are used for testing the significance difference between the samples.

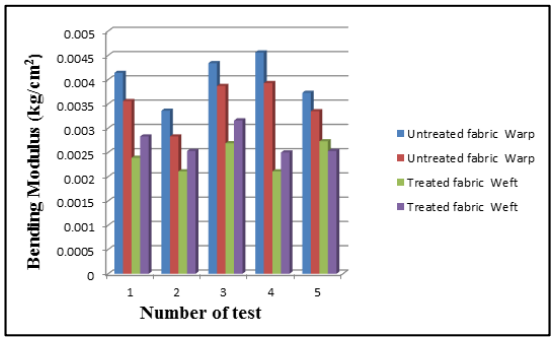
ANOVA TABLE FOR WARP WAY BENDING MODULUS

ANOVA: Single Factor		α	0.05				
SUMMARY							
Groups		Count	Sum	Average	Variance		
Untreated	Warp	5	0.02013	0.004026	2.32		
Treated	Warp	5	0.01754	0.003508	1.99		
Source of Variation		SS	Df	MS	F	P-Value	F critical
Between Groups		6.71	1	6.71	3.112	0.116	5.317
Within Groups		1.72	8	2.16			
Total		2.4	9				

ANOVA TABLE FOR WEFT WAY BENDING MODULUS

ANOVA: Single Factor		α	0.05				
SUMMARY							
Groups		Count	Sum	Average	Variance		
Untreated	Weft	5	0.01203	0.002406	9.03E-08		
Treated	Weft	5	0.01355	0.00271	8.15E-08		
Source of Variation		SS	Df	MS	F	P-Value	F critical
Between Groups		2.31	1	2.31E-07	2.690735	0.140	5.317655
Within Groups		6.87	8	8.59E-07			
Total		9.18	9				

Result: F value is lesser than the F critical. Therefore null hypothesis is accepted. This shows that no significant difference arises in the treated and untreated fabric after dyed with seaweed.



BENDING MODULUS

Analysis the Crease Recovery Properties

A wrinkle free rectangular specimen of prescribed dimensions is folded in half. Then the specimen is compressed under a load for a specified time. The load is then removed and the specimen is allowed to recover for the same specified time. The amount of recovery is expressed as the angle between the limbs of the fold, which is called the crease recovery angle.

Significant difference between treated and untreated fabrics

CREASE RECOVERY TEST

S. No	Untreated Fabric		Treated Fabric	
	Warp way Crease Recovery Angle (°)	Weft Way Crease Recovery Angle (°)	Warp Way Crease Recovery Angle (°)	Weft Way Crease Recovery Angle (°)
1.	68	67	69	65
2.	70	72	72	70
3.	71	73	72	71
4.	69	71	71	74
5.	68	73	69	73
Total	346	356	353	353
Mean	69.2	71.2	70.6	70.6

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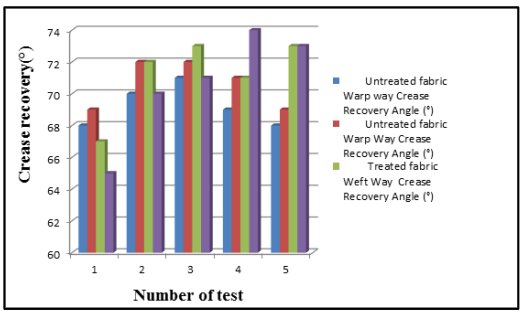
ANOVA TABLE FOR WARP WAY CREASE RECOVERY

ANOVA: Single Factor		α	0.05				
SUMMARY							
Groups		Coun	Sum	Average	Variance		
Untreated	Warp Way	5	346	69.2	1.7		
Treated	Warp Way	5	353	70.6	2.3		
Source of Variation		SS	Df	MS	F	P-Value	F critica
Between Groups		4.9	1	4.9	2.45	0.156	5.317655
Within Groups		16	8	2			
Total		20.9	9				

ANOVA TABLE FOR WEFT WAY CREASE RECOVERY

ANOVA: Single Facto		A	0.05				
SUMMARY							
Groups		Count	Sum	Average	Variance		
Untreated	Warp Way	5	356	71.2	6.2		
Treated	Warp Way	5	353	70.6	12.3		
ANOVA							
Source of Variation		SS	Df	MS	F	P-Value	F critical
Between Groups		0.9	1	0.9	0.097297	0.763	5.317655
Within Groups		74	8	9.25			
Total		74.9	9				

Result: F value is lesser than the F critical. Therefore null hypothesis is accepted. This shows that no significant difference arises in the treated and untreated fabric after dyed with seaweed.



Crease Recovery

The result shows that the treated fabric was allowed to recover for the same specified time than the untreated fabric but there is a slight difference in the recovery angle due to the dyeing condition on the fabrics.

Analysis the Rubbing Fastness Properties

Rubbing fastness test is an important factor in the physical performance of textile materials and it is used to provide an indication of the removal of dye molecules on the surface of the fabric during rubbing on both dry and wet samples.

RUBBING FASTNESS TEST

S. No	Particulars	Rating
1.	The numerical rating for change in colour of the dry specimen	5
2.	The numerical rating for change in colour of the wet specimen	4
3.	The numerical rating for change in colour of the dry-wet specimen	4
4.	The numerical rating for change in colour of the wet-dry specimen	4-5

The result shows that for the dry samples, the rubbing fastness properties are good, when comparing to wet samples. In wet sample, the surface treated dyes are removed after repeated rubbing as per the ASTM (08) standard and the grade result shows that it is in the range of Good to Excellent.

GRADE VALUE OF RUBBING FASTNESS

S.NO	Grade
1.	Excellent
2.	Good
3.	Fair
4.	Poor
5.	Very poor

The test results are verified and compared with AATCC and standard (ISO international standard 105/A02). In the dry state of treated fabric shows good fastness property, because of the strong fixing of dye molecules on the intermolecular structure of the fabric, so the affinity of the dye fibre bond fixed with seaweed dye are very strong and it will form covalent bonds in-between the dye and fibre. Therefore such treated fabric is most widely used for curing degenerative diseases.

Analysis the Water Spray Characteristics:

It is the ability of the fabric to take up a liquid. It is a term related to the warmth of a fabric. If a fabric is permeable to air, water and evaporation of perspiration takes place from the skin and the skin temperature falls. If the fabric absorbs the perspiration, however the evaporation takes place from the fabric and not from the skin.

The Water absorbency result of the bed cover and face mask is shown in Table.4.25. As per the result, the time taken for absorb the water droplet has no significant difference between treated and untreated fabric. When the time increases the absorbency decreases and vice versa.

Thus the water absorbency first increases and the decreases was mainly due to the moisture transport properties of the fibres present in the fabric and the time increases it would be same for both treated and untreated fabric. The treated fabric will not affect by water absorbency property on the surface of the fabric and this property is more important for wound dressing material, skin cancer, hospital bed cover and face mask fabrics.

WATER SPRAY

Numbers	Status
100	No sticking or wetting of upper surface.
90	Slight random sticking or wetting of upper surface.

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80	Wetting of upper surface at spray points.
70	Partial wetting of whole of upper surface.
50	Complete wetting of whole of upper surface.
0	**Complete wetting of whole upper and lower surfaces.**

Analysis the Tensile Strength: of Treated and Untreated Fabrics

The physical properties of textile material such as tensile strength are more important for hospital bed cover for durability and better serviceability of the fabric. The result shows that the tensile strength increases with decrease in elongation in the case of untreated fabric but
in the case of treated fabric the tensile strength decreases with increase in elongation of the fabric. This result was mainly due to bio scoured; bio bleached and dye bath temperature for dyeing. As per result, a significant

difference occurs in the tensile strength and elongation properties of treated and untreated fabrics.

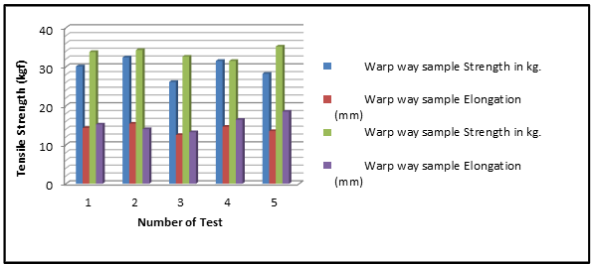
TENSILE STRENGTH OF TREATED AND UNTREATED FABRIC

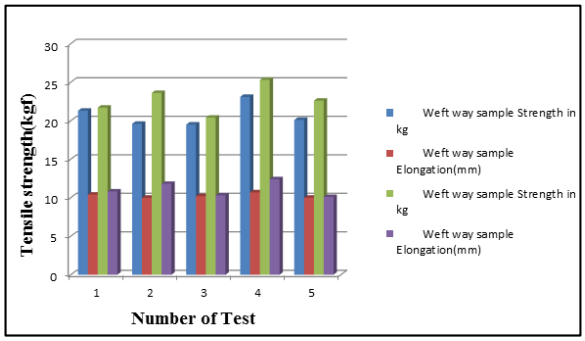
S. No	Untreated Fabric		Treated Fabric	
	Warp way sample		Weft way sample	
	Strength in kg.	Elongation (mm)	Strength in kg	Elongation (mm)
1.	30.1	14.3	21.3	10.4
2.	32.4	15.4	19.6	10
3.	26.1	12.5	19.5	10.2
4.	31.5	14.6	23.1	10.7
5.	28.2	13.5	20.1	10

ANOVA TABLE FOR WARP WAY TENSILE STRENGTH

ANOVA: Two Factor Without Replication			α	0.05			
SUMMARY		Count	sum	Average	Variance		
	1	4	93.4	23.35	101.03		
	2	4	96.1	24.025	116.869		
	3	4	84.4	21.1	97.8733		
	4	4	94	23.5	85.8733		
	5	4	95.4	23.85	94.4966		
Strength in kg		5	148.3	29.66	6.473		
Elongation		5	70.3	14.06	1.223		
Strength in kg		5	167.4	33.48	2.107		
Elongation		5	77.3	15.46	4.358		
ANOVA							
Source of Variation		SS	Df	MS	F	P-Value	F critica
Rows		2168.947	4	542.2367	-4.48064	0.012	2.964708
Columns		3600.73	3	1200.243	-9.91791	0.001	3.196777
Error		-2057.3	17	-121.018			
Total		3712.374	24				

Result: F value is larger than the F critical. Therefore null hypothesis is rejected. This shows that major significant difference arises in the treated and untreated fabric after dyed with seaweed.





TENSILE STRENGTH

The statistical tools used for verifying the significance difference between the treated and untreated samples was ANOVA tools. In this property, we can use two way ANOVA without replication are used for testing the significance difference between the samples.

ANOVA TABLE FOR WEFT WAY TENSILE STRENGTH

ANOVA: Two Factor Without Replicatio			□□□□□□□□□□□□	0.05			
SUMMARY		count	sum	Average	Variance		
	1	4	64.2	16.05	39.6566 7		
	2	4	65	16.25	41.37		
	3	4	60.4	15.1	31.5		
	4	4	71.5	17.875	54.6291 7		
	5	4	62.8	15.7	43.6066 7		
Strength in kg		5	103.6	20.72	2.282		
Elongation		5	51.3	10.26	0.088		
Strength in kg		5	113.6	22.72	3.467		
Elongation		5	55.4	11.08	0.977		
Source of Variation		SS	Df	MS	F	P-Value	F critical
Rows		1066.27 4	4	266.568 5	-4.60527	0.011	5.96470 8
Columns		1671.30 6	3	557.101 9	-9.62455	0.001	3.19677 7
Error		-984.018	17	-57.8834			
Total		1753.56 2	24				

Result: F value is larger than the F critical. Therefore null hypothesis is rejected. This shows that major significant

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difference arises in the treated and untreated fabric after dyed with seaweed.

Analysis the Tearing Strength of Treated and Untreated Fabrics

Tearing strength are important for better durability and serviceability of textile materials such as parachute cloth, sail cloth, fire resistance fabric etc. In the case of medical fabric only minimum amount of tearing strength are necessary. The results shows that, tearing strength increases for untreated fabric compared with treated fabric, but such significant difference was not affected for medical purpose .The tearing strength was more suitable for hospital bed cover, surgical gowns, compression bandage etc.

TEARING STRENGTH TEST

S. No	Untreated Fabric		Treated Fabric	
	Warp (kgf)	Weft (kgf)	Warp (kgf)	Weft (kgf)
1.	2.89	3.24	2.72	3.20
2.	2.75	3.03	2.70	2.89
3.	2.82	3.52	2.63	3.15
4.	2.83	3.59	2.81	3.53
5.	2.68	3.17	2.61	2.78

The statistical tools used for verifying the significance difference between the treated and untreated samples was ANOVA tools. In our project, we can use one way ANOVA with two variables are used for testing the significance difference between the samples.

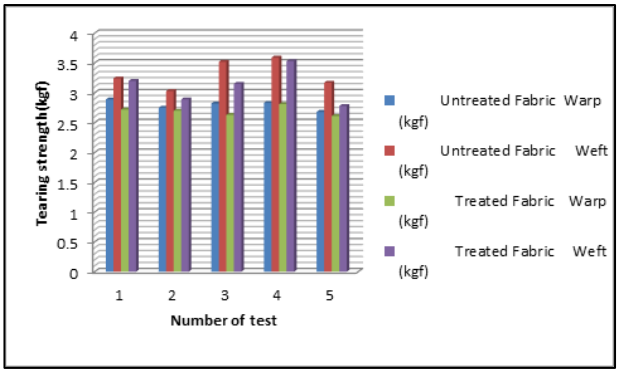
ANOVA TABLE FOR WARP WAY TEARING STRENGTH

ANOVA: Single Facto		α	0.05				
SUMMARY							
Groups		Count	Sum	Average	Variance		
Untreated	Warp Way	5	13.97	2.794	0.00653		
Treated	Warp Way	5	13.52	2.704	0.00973		
ANOVA							
Source of Variation		SS	Df	MS	F	P-Value	F critica
Between Groups		0.02025	1	0.02025	2.490775	0.153	5.317655
Within Groups		0.06504	8	0.00813			
Total		0.08529	9				

ANOVA TABLE FOR WEFT WAY TEARING STRENGTH

ANOVA: Single Facto		A	0.05				
SUMMARY							
Groups		Count	Sum	Average	Variance		
Untreated	Weft Way	5	16.55	3.31	0.05635		
Treated	Weft Way	5	15.61	3.122	0.08927		
ANOVA							
Source of Variation		SS	Df	MS	F	P-Value	F critica
Between Groups		0.08836	1	0.08836	1.21357	0.303	5.317655
Within Groups		0.58248	8	0.07281			
Total		0.67084	9				

Result: F value is lesser than the F critical. Therefore null hypothesis is accepted. This shows that no significant difference arises in the treated and untreated fabric after dyed with seaweed.



TEARING STRENGTH

Analysis of Washing Fastness of Treated Fabric

Washing fastness test is an important factor in the physical performance of textile materials and it is used to provide an indication of the removal of dye molecule present on the surface of the fabric and it will affect the performance and aesthetic value of the fabric. The result shows that the washing fastness properties are good for the treated material, when compared with untreated fabrics. The treated fabric had very good performance after repeated washing. The treated fabric was washing with different cycles (5, 10, 15, and 20). In each stage of washing take place, the grade changes for colour and white fabric was in the range of 4-5

GRADE VALUE OF WASHING FASTNESS

S.No	Grade
1.	Excellent
2.	Good
3.	Fair
4.	Poor
5.	Very poor

The result clearly proved that even dyeing take place in between the Intermolecular structure of the yarn present in the treated fabric .The amount of dyes absorbed on the fabric was not cleavage between the fibre and dye present in the yarn and it also formed strong covalent bond between the fibre will leads to uniform dye uptake and minimum amount of dyes are removed on the fabric during repeated washing after 20 cycles.

WASHING FASTNESS TEST

Cycle of Washing	Fabric Types	Evaluate the Colour Change Grade	Evaluate the Staining Grade
5	Treated fabric	5	4.5
10	Treated fabric	5	4.5
15	Treated fabric	5	4.5
20	Treated fabric	5	4.5

Analysis the Wicking Behaviour of Treated and Untreated Fabrics

Wickability test is an important factor in the performance of textile materials for testing the comfort properties and it is used to provide an indication of the breathability of fabrics.

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Wickability is mainly due to the presence of moisture content present in the fibers. This test is used to find the water absorbency on the strip of fabric against time in seconds.

The result shows that treated samples are absorbed little less compared with untreated samples because of the seaweed dyes are present in the intermolecular structure between the yarns and it will increase the weight of the fabric and break the weak bonds to form strong covalent bonds. Test result is given below,

WICKABILITY TEST

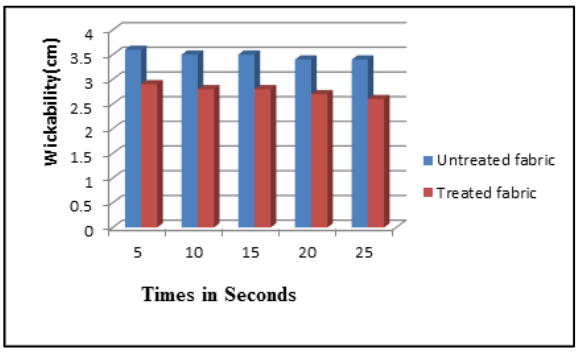
S. No	Time (Sec)	Untreated fabric	Treated fabric
1.	5	3.6	2.9
2.	10	3.5	2.8
3.	15	3.5	2.8
4.	20	3.4	2.7
5.	25	3.4	2.6

The statistical tools used for verifying the significance difference between the treated and untreated samples was ANOVA tools. In our project, we can use one way ANOVA with two variables are used for testing the significance difference between the samples.

ANOVA TABLE FOR WICKABILITY TEST

ANOVA: Single Facto	A	0.05				
SUMMARY						
Groups	Count	Sum	Average	Variance		
Untreated	5	17.8	3.56	0.023		
Treated	5	13.6	2.72	0.027		
Source of Variation	SS	Df	MS	F	P-Value	F critica
Between Groups	1.764	1	1.764	7.56	0.000	5.317655
Within Groups	0.2	8	0.025			
Total	1.964	9				

Result: F value is greater than the F critical. Therefore null hypothesis is rejected. This shows that a major significant difference arises in the treated and untreated fabric after dyed with seaweed.



WICKABILITY TEST

As per the result, there is a major significant difference between the untreated and treated fabric because of bio scouring, bio bleaching and dyeing take place in the treated fabric.

Medical Evaluation of Non-Implantable Materials

Anti-Allergy Test

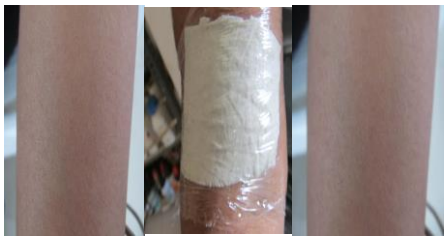
The fabric patched on the normal skin was observed for the specified period of time for the development of
the symptoms related to contact dermatitis allergy. Non hairy part of the skin of the subjects was selected. The surface of the skin was cleaned with moistened sterile cotton swabs.

The patches of the treated fabric sample were made and plastered on the surface of the cleaned skin. The site of patching was observed for any immediate allergic response. Observations were made up to 24 hours for the symptoms such as skin rashes, redness and irritations.

(Erythema and oedema). The time of observation may be extended for another 24 hours to confirm the effect.

EVALUATION OF THE ANTI-ALLERGY ACTIVITY

S. No	Samples	Subject 1	Subject 2	Subject 3
1.	ulva lactuca finished fabric	NIR	NIR	NIR



BEFORE PATCH FABRIC CONTACT WITH SKIN AFTER PATCH

ANTI-ALLERGY TEST

Evaluation: After the contact time, the fabric patches were removed and observed for the following reactions
(NIR) - No irritant reaction
(IR) - Irritant reaction
We should apply the treated fabrics to three patients and the result produced was very good for all. Therefore such treated fabrics are used for medical textiles for curing degenerative and also for health and hygienic applications.

CONCLUSION

Seaweed samples (Red, Brown and Green algae) were collected from different sites located in the mandapam of Ramanathapuram districts were screened for dyes extraction, antioxidant and antibacterial activity.

The dyes extracted from five types of seaweed using acetone as a solvent in Soxhlet apparatus for better utilization of natural resources of colour pigments for their use in textiles.

The bio-active compounds present in seaweeds are very important for developed the growth of cells in skin and it possess good anti-oxidant anti-bacterial properties and these bio-active compounds present in seaweeds dyes and treated fabric was confirmed by the spectrum produced in UV-spectroscopy and FTIR spectroscopy analysis.

Anti-oxidant properties of seaweeds were confirmed by using DPPH free radical scavenging activity. The results suggest that the presence of phenol, flavonoids and fucoidan compounds should be major contributors for anti-oxidant activity.

Anti-bacterial activity of seaweed dyes and treated fabric was confirmed by using disc diffusion and parallel streak

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method. The results indicate that ulva Lactuca extracts exhibit a promising anti-bacterial activity against pathogenic bacteria such as staphylococcus aureus and E-coli as per ASTM 147-2004. The maximum zone of inhibition was around 27mm in ulva Lactuca species compared to other seaweeds. Compared to untreated samples, seaweed treated fabrics shows higher resistance to anti allergic properties. These treated fabrics are used for making non-implantable materials such as bed covers, face masks and sun protective gloves.

This treated fabric has better durability to repeated washing and the antimicrobial property remains withstand after 20 washing. The finding of this study suggests that these non-implantable products are used for medical applications in health and hygienic textiles.

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