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Development of *Agave Americana* Anti-Bacterial Fabric for Healthcare Applications

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ABSTRACT: Textiles are used in different sectors and various purposes beyond imagination. Medical sector is one of them. An important and emerging part of the textile industry is medical, hygiene and health sector. The medical textile industries have diversified with new materials and innovative designs. Recently, the application of textiles has on track going beyond the usual wound dressings, incontinence pads and plasters etc. Among these vast categories of medical textile products, the hospital textiles play an important role and also expected to fulfill the hygienic, comfort and microbial resistance property requirements. These functional requirements of hospital textiles have led to the innovative use of a variety of natural fibers with enhanced comfort and hygienic properties in the development of new products for medical applications. The *Agave Americana* plant is one of the very important natural resource which is available in the tropical areas with plenty of hygienic properties. Based on the view, the Americana plant leaves are collected and extracted by mechanical process. After the extraction the fibers are converted into yarn and fabric forms for the different medical end uses. The extraction was done by using the Box and benken optimized process conditions. The anti-bacterial property was tested on fabric using standard AATCC 147 qualitative and AATCC 100 quantitative tests against both positive and negative bacteria with 24 and 48 hour time duration. The anti-bacterial property of *Agave Americana* fabric was also compared with standard antibiotics. The test result shows that the *Agave Americana* fiber has good antibacterial activity against the gram negative *Escheirchia Coli* (32mm & 42mm) bacteria than gram positive *Staphylococcus aureus* (23mm & 35mm) bacteria. *Agave Americana* fiber has showed higher zone of inhibition against standard antibiotics. Based on the results, the developed anti-bacterial *Agave Americana* fabric will be most suitable for medical and health care applications.

KEY WORDS: *Agave Americana*, Antibacterial activity, NaOH softening,

I. INTRODUCTION

Nature has been a source of medicinal agents for thousands of years and an impressive number of modern drugs have been isolated from natural resources. Traditional medicines are important source of potentially useful compounds for the development of chemotherapeutic agents^[1]. India being a tropical country is blessed with plenty of renewable natural resources obtainable from the plant kingdom. There are various plants in the kingdom which are having good medical properties, but due to lack of information and time consumption is not widely spread. Recently, the different ranges of natural fibers and biodegradable polymers are being utilized for developing new products into medical textiles. The medical textile applications are directly related to the skin and also life of human being, those are required to undergo stringent testing and hygienic criteria, which led to innovative use of variety of fibers and a lot of developments taking place in this area. Different parts in the plant kingdom has own different uses. From the plant kingdom, one of the abundant sources of strong natural fiber is *Agave Americana*^[2,3]. *Agave Americana* plant is found to possess better antibiotic properties under laboratory conditions, the leading researchers to think this fiber may be effective in the treatment of both *staphylococcus* and *Escherichia coli* bacteria strains. Recent studies on antibacterial activity, it is more effective in inhibiting growth of various bacteria. In this present investigation, the softening of fiber and quality aspects of *Agave Americana* yarn and fabric were analyzed and also the effect of antibacterial activity were investigated against gram positive bacterial strains.

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II. MATERIALS AND METHODS

Selection of Natural Resource

Agave Americana fiber is a natural fiber, which are vastly available in and around the area of central and North America. Agave is most commonly grown as an ornamental plant, and it is spread throughout the temperate and tropical areas around the world. It has various medicinal and disease curing properties.

Extraction of *Agave Americana* fiber

Agave Americana leaves were scratch down from the plant and the fibers were extracted by using mechanical method. In the process of extraction, the leaves were dipped in to the water for about 10 to 15 days. Then, the leaves were taken and outer layer was removed with the help of mechanical beating process and finally the fiber was washed and then dried.



Fig.1 *Agave Americana* leaves



Fig.2 *Agave Americana* fiber

Softening Treatment on Fiber

The box-behenken optimization technique was used to optimize the different softening chemical concentration, treatment time and processing temperature. For softening the fibre, the optimized chemical concentration of NaOH-4% time duration -4hr and temperature -60°C were used and the fiber softening results were analyzed by ring loop method.^[4,6].The fibre samples were converted in fabric form.

Antibacterial Assessment Methods

AATCC-147-1998 (USA): Qualitative antibacterial assessment of diffusible antibacterial agents (“quick method”) – Agar diffusion test

25ml of nutrient agar was prepared and sterilized at 121°C for 15 minutes. Petri plates were autoclaved in hot air oven at 121°C for 30 minutes. 20ml of Nutrient agar was poured into each of these plates and were allowed to solidify. A series of 8 test tubes containing 4.5ml of sterile water was taken. 0.5ml of culture from nutrient broth containing the *Agave Americana* fabric sample was transferred aseptically into the first test tube. Serial dilution was carried out until its reduced dilution was 10⁻⁸. 100 micro liters of 10⁻⁸ diluted culture was taken aseptically and poured onto the petri plates. This was spreaded by using L rod. The plates were incubated at 37°C for 24-48 hours. Similar procedure was carried out for all other samples.

AATCC-100-1998 (USA): Quantitative assessment of antibacterial finishes on textiles-measures the degree of antibacterial activity- Broth dilution test

The *Agave Americana* fabric samples were taken for broth dilution test. In each conical flask, the 50ml of Nutrient broth powder was weighed and mixed with distilled water. Then the solution was stirred well. 100µl *Staphylococcus aureus* bacteria were added into 2 conical flasks which contain the *Agave Americana* samples and standard. Similarly 100µl *Escherichia coli* bacteria were added into 2 conical flasks which *Agave Americana* samples and standard. Then the flasks were kept in a shaker for 24 hours under medium speed at room temperature. Then the 2gms of Nutrient broth was diluted with distilled water to measure the blank which was used to set as zero calibration. Before taking the

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readings, the machine was calibrated at 600 nm and the readings were noted .The Reduction percentage of the absorption values were calculated using the formula: $\text{Reduction \%} = \frac{C-T}{C} \times 100$ -Where C=control of respective bacteria=value of tested fabric.

III. RESULTS AND DISCUSSION

a. AATCC-147-1998 (USA): Qualitative antibacterial assessment of diffusible antibacterial agents (“quick method”) – Agar diffusion test

The antibacterial activity of *Agave Americana* fabric results are listed in the Table I.

Table –I
Qualitative analysis of Zone of inhibition of *Agave Americana* fabric

Samples	Antibacterial activity (zone of inhibition in mm) against <i>Staphylococcus aureus</i> bacteria		Antibacterial activity (zone of inhibition in mm) against <i>Escheirchia Coli</i> bacteria	
	24 hrs	48 hrs	24 hrs	48 hrs
<i>Agave Americana</i> fabric	23	35	32	42
Antibiotic	18	20	25	20

From the Table-1, the results shows that the *Agave Americana* fabric has higher zone of inhibition against gram negative E.Coli (32mm & 42mm) bacteria than gram positive *Staphylococcus aureus* (23mm & 35mm) bacteria when compared to standard antibiotic. The *Agave Americana* fabric has indicated better anti bacterial activity against both gram negative and positive bacterial strains after 24 and 48 hrs.

b. AATCC-100-1998 (USA): Quantitative assessment of antibacterial finishes on textiles-measures the degree of antibacterial activity- Broth dilution test

The antibacterial activity of *Agave Americana* fabric results are listed in the Table II.

Table II
Quantitative analysis of test results of *Agave Americana* fabric (Broth dilution test)

Samples	Antibacterial activity (Absorbance value OD at 600 nm)			
	<i>Staphylococcus aureus</i> bacteria (nm)		<i>Escheirchia Coli</i> bacteria (nm)	
	24 hrs	48 hrs	24 hrs	48 hrs
<i>Agave Americana</i> fabric	1.50	1.65	1.71	1.85
Antibiotic	1.35	1.50	1.42	1.76

From the Table-2, the quantitative result shows that the *Agave Americana* fabric has good absorbance value in 24 and 48 hrs time treatments against gram negative and positive bacteria when compared to standard antibiotic. The OD value of agave americana fabric showed that better bacterial reduction percentage and good activity against gram negative *E. Coli* (1.71 & 1.85 nm) than gram positive *Staphylococcus aureus* (1.50nm & 1.65nm) bacteria strains.

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III. CONCLUSION

From the test results, we have concluded that *Agave Americana* fabric has softened better in NaOH with optimized conditions. It also proved that, the *Agave Americana* fibre has good zone of inhibition against the gram negative *E.Coli* (32mm & 42mm) than gram positive *Staphylococcus aureus* (23mm & 35mm) bacteria. The OD value also represented that the *Agave Americana* fabric has good antibacterial activity against gram negative bacteria than gram positive bacteria compared with standard antibiotic. Hence, the newly developed *Agave Americana* fabric has proved its antibacterial property and better results in hygienic qualities. This research work will lay a foundation for renewable wealth out of waste materials from new innovative products for different end uses.

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