TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 4507 - 4512

Green Synthesis of Silver Nanoparticle Using LeucasAspera Plant Extract and Its Antimicrobial Activity on Lyocell Fabric

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Article Info
Volume 82
Page Number: 4507 - 4512
Publication Issue:
January-February 2020

Abstract

Nanotechnology is a emerging field in the textile sector. Nanoparticles has a completely new properties like size, shape and morphology. Nanoparticle production makes use of lots of chemicals and toxic solvents which limit their use in various applications.So therefore green non toxic method is very essential for synthesizing nanoparticles for wider applications. This can be achieved by using ecofriendly methods. Plant is a very good option for nanoparticles synthesis which has various advantages when compared to other methods. Nanotechnology is one of the method which provides ecofriendly products as. Plant is the best option among all other biological methods which is easy to synthesis and very safe when compare to physical and chemical methods .Silver is a very good antimicrobial agent, which has good resistance againt various micro-organism .Now silver is very commonly used in various medical applications. In this article study was conducted by using four different medicinal plants with antimicrobial activity and green synthesis of nanoparticle was made with the plant which has very good antimicrobial activity. Lyocell is natural cellulose fiber made from dissolving pulp. Lyocell has a very good properties like moisture absorption, biocompatible , ecofriendly. In this study biologically synthesized silver nanosynthesis was made using leucasaspera plant extract and nanofinish was incorporated in lyocell fabric.

Article History
Article Received: 18 May 2019
Revised: 14 July 2019
Accepted: 22 December 2019
Publication: 22 January 2020

Key Words :*Nanotechnology, silver, green synthesis, Lyocell, Leucasaspera*

I. INTRODUCTION

The textile and apparel industry are one fast growing sector .Textile industry employ 38 million people and a largest source for employement for people of India. Nanotechnology is a fast growing field in the textile sector [1]. Biological methods for synthesis is mainly done using micro-organism , enzyme and plant. Among all these biological methods plant seems to be the best alternative which is cost effective and environmentally friendly. Using plant for nanoparticles synthesis has varies advantages when compare to physical and chemical method for nano synthesis. [4].

Nanotechnologies have revolutionized the textile industry by providing environmentally safe products. Synthesis of nanomaterials by biological method is cheaper ,requires less time, and less labour requirement [5]. Nanoparticles produced by

January - February 2020
ISSN: 0193 - 4120 Page No. 4507 - 4512

plants are more stable. The rate of production is also very faster when compare to chemical and physical methods. Thus, biological synthesis of nanopartical has various advantage when compare to other methods which have instigated reasearchers to take up this field.[6].

Metal ions plays a good role in green synthesis of nanoparticles. Different metal ions can be used for nanosynthesis among various metal ions silver is very commonly used because of its very less cost when compare to gold, copper metal ions and has a very good antimicrobial property[8].

Lyocell is a natural cellulosic fiber which is made by dissolving wood pulp. The important properties of lyocell fabric are ecofriendly, moisture absorption and bio compatability. So the fabric is suitable for making wound care products. Considering the above facts, the study was planned to synthesis of silver nanoparticle by plant extracts of the selected herb for the development of wound care dressing utilizing the herbs Calotrophis gigantean, Leucasaspera, Morusalba, coleneusambonicus.

II.MATERIALS AND METHODS

2.1 Selection of herbs

Four different herbs with antimicrobial activity and medicinal property were selected for the study, which includes CalotropisGigantea, Morusalba, Leucasaspera, Coleus amboinicus. These selected herbs are easily available and found in tropical region and in wasteland. They were used traditional by our ancient people for curing wounds and has good wound healing property.

2.2 Collection and preparation of herbs

The four different herbs, which includes Calotropisgigantea, Morus alba, Leucasaspera, Coleus amboinicus were collected from Coimbatore district, Tamilnadu . The 3 kg of leaves of all herbs were collected manually and washed thoroughly with water and allowed to shade dry. The collected plants were dried at the room temperature to avoid breaking down of various compounds from sunlight. When the plant samples are completely dried , it is now taken for grinding to convert into powder form for further process.

2.3 Grinding and powdering process

Grinding is mainly done to break large particles into smaller one. The dried leaves were cut into small pieces. Now the small broken pieces were taken to the mixer and grinded into fine powder. Now the fine powder was taken for further process. The fine powder obtained was used for plant solvent extraction .The extraction was done by aqueous extraction. Now the powder is taken for solvent extraction.

2.4 Solvent extraction

The solvent plays a major role extraction. The solvent selected for the study is aqueous, the aqueous is a high polar solvent which will be able to dissolve phytoconstituents in the herb. Hence from my study aqueous was used for extract preparation.

2.5 Preparation of plant extract

The powdered leaf sample measuring 5 grams were dispensed in 50 ml of distilled water and boiled for 30 min at 60 degree celcius in the water bath. And the extract was allowed to cool for 20 min and filtered using whatmann filter paper. Now the collected extract was used for further findings.

2.6 Antibacterial activity by well diffusion method

2.6.1 Well Diffusion Method- Screening the best herb

All the four-plant extract from aqueous were qualitatively assessed for antibacterial activity. The test was done with two test organism which includes gram positive bacteria Staphylococcus aureus and gram-negative bacteria Escherichia coli.

2.6.1.1 Inoculum preparation

The inoculum for the experiment were prepared in fresh nutrient broth from preserved slant culture.

January - February 2020
ISSN: 0193 - 4120 Page No. 4507 - 4512

The standardization was done by adjusting the turbity of the culture to that of Mcfarland standards

2.6.1.2 Experiment

The antibacterial activity of each herbal extracts (H1, H2, H3, H4) were evaluated against the significant organisms (Escherichia coli and Staphylococcus aureus) by well diffusion method. Sterile Nutrient Agar (Composition g/L: Peptone: 5g; Yeast extract: 5g, Beef extract: 3g, Sodium chloride: 5g, Agar 15 g; Final pH (7.0 ± 0.2) plates were prepared and allowed to solidify. About 0.1% inoculum suspensions of test bacterial cultures were swabbed uniformly over each agar plate surface. Under sterile conditions, 6mm wells were cut on the agar surface of each Nutrient Agar (NA) plates. About 50µl each of medicinal herbal extract dissolved in 5% dimethyl sulfoxide (DMSO) were loaded into the well and the plates were incubated at 37ºC for 24 - 48h. The antibacterial activity was evaluated in terms of zone of inhibition around the wells of each extract in all the inoculated NA plates.

2.7 Fourier transform infrared spectroscopy (FTIR) analysis of selected herb extract

The selected herb was subjected to FTIR analysis which is mainly used to identify the functional groups present in the plant. The FTIR spectra for the leaf extract Leucasaspera was obtained in the range 4,000 to 800cm-1 with an IR-Prestige-21 shimadzu FTIR spectrophotometer, by KBr pellet method. FTIR was an analytical tool to identify the chemical group present in the plant extract

2.8 Preparing solvent extraction by selected herb Leucasaspera

Bulk preparation of selected herb extract is done for further nano finishing. The Leucasaspera leaf sample measuring 10 grams were dispensed in 100ml distilled water. Now the leaf extract is placed in the water bath for 30 min at 60 degree Celsius, after that the plant solution is allowed to cool for 20 min. Now the cooled solution is filtered using filter paper and taken for further proceedings.

2.9 Preparation of silver nitrate extract

The $AgNO_3$ used for the study is 1mM. The silver nitrate solution was prepared by using 1000 ml deionized water. 169.87 mg silver nitrate was dispensed in 1000ml deionized water and mixed well and used for further study.

2.9.1 Greensynthesis of silver nanoparticles using Leucasaspera leaf extract

To 90ml deionized solution of 1Mm silver nitrate, 10 ml plant extract is Then the sample was placed in dark room for 24 hours. After 24 hours, the sample was measured for its maximum absorbance using UV-Visible spectrophotometry. The nanosynthesis was conformed was confirmed by the colour change of solution from light yellow to dark yellow [61].

2.9.2 Characterization of nano extract by UV-visible spectrophotometer

The formation of silvernanoparticle from plant extract was conformed by Uv visible spectroscopy . It is done by analyzing the Uv visible spectrum of the plant extract. Usually the wavelength ranges from 200 to 800 nm. Usually the nanoparticle is conformed by the peak at 530nm wavelength. Broadening of peaks at the base indicates the nanoparticles are polydispersed.

2.9.3 Selection of fabric

Fabric selection is a very important step in designing a product. Each and every fabric has its own features and applications. The fabric which is used for one purpose is not suitable for other purpose. Considering the properties of lyocell

- Moisture absorption,
- Biocompatibility
- Moisture transmission, 100% Lyocell fabric is chosen for developing an wound care dressing and suitable for medical textiles.

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 4507 - 4512

2.10 Fabric finishing

2.10.1 Pad dry cure method

The fabric finishing was done using pad -dry and cure method. Here the lyocell nonwoven fabric is taken and dipped in the green synthesized leucasaspera plant extract for four hours. After that the dipped fabric is padded in a padding mangle, the excess liquid is squeezed out from the rollers and cured at 80-degree Celsius. Now the fabric is taken for further findings.

III.RESULTS AND DISCUSSION

3.1 Screening of best herb by well diffusion method

The prepared plant extracts of Leucasaspera, Calotropisgigantea, Morus alba, Coleus amboinicus are subjected to disc diffusion method and screened for their antimicrobial property and the best herb is selected based on the zone of incubation are selected. The results obtained are given below table 2 and plate 5 and 6 and fig 25.

Table: 2 Antibacterial activity by well diffusion method

PLATE 1

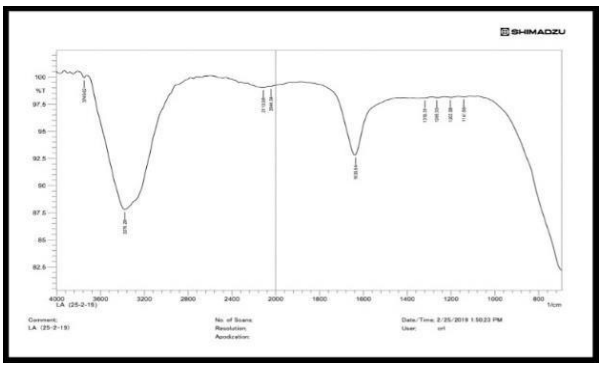
PLATE 2

From Plate 1and plate 2, shows the result of screening of plants by well diffusion method. The zone of inhibition varies for each and every plant are in mm. For the selected two organisms the plant extract of Leucasaspera shows the maximum zone of inhibition 21mm and 18 mm against Escherichia coli and Staphylococcus aureus. All the other plant extracts shows considerable amount of zone of inhibition from 5 to 12mm. From the result Leucasaspera were selected for study.

3.2Fourier transform infrared spectroscopy (FTIR) analysis of Leucasaspera plant extract

The selected plant extract was subjected for FTIR analysis. The plant extract shows the presence of various functional groups and various absorbency points.

Fig:1 FTIR analysis of Leucasaspera plant extract



The above FTIR figure shows the presence of absorbency points at various peaks.

3.3 Biological synthesis of silver nanoparticles using Leucasaspera leaf extract

The aqueous extract of green synthesized silver nanoparticle is confirmed by colour change from light yellow to dark yellow which indicates the presence of AgNPs particles in the plant extract. The colour change is observed after 24 hours placed in the dark room.

Color change observation for Leucasaspera plant extract

January - February 2020
ISSN: 0193 - 4120 Page No. 4507 - 4512

Fig 2 Beforecolour change

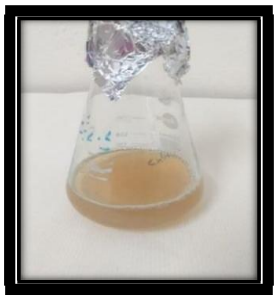


Fig 3 Aftercolour change

The color changes from light yellow to dark yellow after 24 hrs which indicates the presence of silver nanoparticles Fig 2 and 3.

3.4 Physical characterization of nano extract -Uv Vis Spectroscopy

UV-vis is a method is used to identify the presence of silver nanoparticles present in nano solution. The biosynthesized silver nanoparticles using Leucasaspera plant extract was examined after 24 hrs using Uv-vis spectrophotometer at a nanometer range of 350-700.

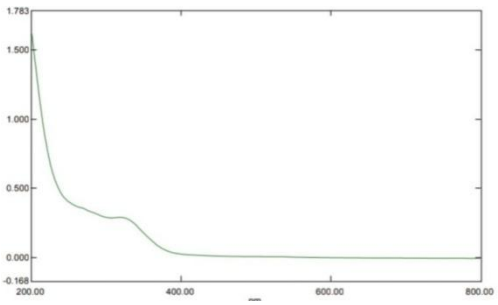


Fig :4Uv -Visible Spectra Analysis

As expressed in the Fig 4, a strong absorption point is maximum located at 530 mm was observed and was due to formation of silver nanoparticles in extract. Absorption spectra of silver nanoparticles formed in the reaction media has absorbance peak at 530 nm, broadening of peak indicated that the particles are polydisperse. Thus, the prepared solution contains silver nanoparticles.

3.5 Antibacterial activity of the finished fabric (EN ISO 20645 test method)

Antibacterial activity of the finished fabric is done using the test method (EN ISO 20645 test method). The antibacterial activity test is done for silver extract fabric and green synthesized nano extract fabric against two bacteria namely Escherichia coli and Pseudomonas aeruginosa. Their results are given below in the plate 3and 4.

Antibacterial activity of the finished fabric

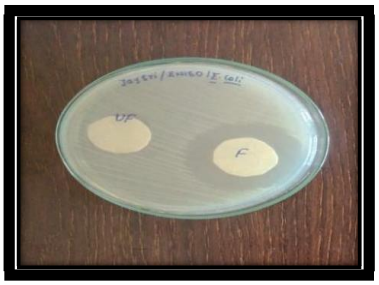


PLATE 3

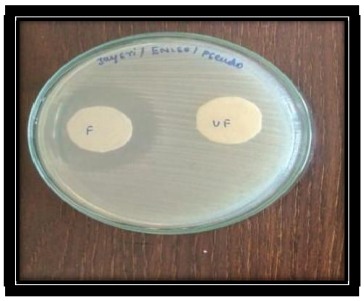


PLATE 4

From the plate 3 and 4, clearly shows the result of antibacterial activity by well diffusion method. The zone of inhibition increases for green synthesized silver nano finished fabric (GNSPs). Green synthesized silver nano finished fabric shows the maximum zone of inhibition 32mm and 31 mm

January - February 2020
ISSN: 0193 - 4120 Page No. 4507 - 4512

against Escherichia coli and Pseudomonas aeruginosa. Silver nitrate extract finished (AgN) shows considerable amount of zone of inhibition from 2.5 mm. From the result we can conclude that green synthesized silver nano extract finished fabric has good antimicrobial activity.

IV. CONCLUSION

Lyocell fabric has a good future scope and many advantages when compare to other cellulosic fiber . The biological method used here is environmental friendly and has lot of advantages over physical and chemical method. The medicinal plant could be used as an excellent material for green synthesis of silver nano particle which can be used for various medical applications Silver nanoparticle synthesized L. aspera extract showed excellent anti-bacterial activity. The method for silver nanoparticle synthesis described in this paper is a green procedure (using environmentally benign natural resources) with a lot of advantages such as eco-friendliness, biocompatibility and cost-effectiveness and can be used for large scale production which requires less labour and cost. The fabric sample finished with green synthesized silver nano particle showed good antimicrobial activity and good absorption property. Hence, it can be concluded that biogenically synthesized silver nanoparticle finish in lyocell fabric can be used for medical applications.

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