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Synthesis and Characterization of PVA-Aloe Vera Blend Nanofiber

X. Joshnaa Catherine[1], T. Malarvizhi[2], S. Durgadevi[3]*

[1]Department of Biotechnology, Sri Shakthi College of Engineering and Technology, Coimbatore-641062, India.
[2]Department of Industrial Biotechnology, Government College of Technology, Coimbatore-641013, India.
[3]Department of Food Technology, Sri Shakthi College of Engineering and Technology, Coimbatore-641062, India.

* Corresponding author email: durga.tbi@gmail.com

ABSTRACT

Nanotechnology is the science which deals with materials which have size ranging from 1-100nm.The nanomaterials can be in the form of cubes, sheets, wires, fibers. They have a wide range of applications in various fields like medical, mechanical, electrical fields. In medical field, nanomaterials are used as diagnostic tools and as carriers for targeted drug delivery. Nanofibers are widely produced by electrospinning method. Electrospun nanofiber shows a number of outstanding properties such as high surface area, light weight and high porosity. The sample solution was prepared using *Aloe Barbadensis* (Aloe vera), *Cynodon dactylon* (arugampul) and polyvinyl alcohol (PVA) with different concentration for the synthesis of nanofiber. The biological activities of aloe vera include promotion of wound healing, antifungal activity, hypoglycemic or antidiabetic effects anti-inflammatory, anticancer, gastro protective properties, and immunomodulatory. Whole plant of *Cynodon dactylon* is traditionally used to treat painful and inflammatory conditions. PVA is a water soluble and biodegradable polymer and is considered as a good candidate for fabrication of composites containing nanofiber. The nanofibers produced can be analyzed by Scanning Electron Microscopy (SEM). The electrospun blend nanofibre will be used for the drug delivery and adsorption process.

Keywords: Nanofibre, Drug delivery, Electrospinning, Adsorption.

1. INTRODUCTION

Nanotechnology is a multidisciplinary field that uses principles from chemistry, biology, physics, and engineering to design and fabricate novel materials in nano size. Nanofibers have many applications such as structure materials in textile field, wound dressings, drug delivery systems and tissue engineering in medical field and as a membrane of filtration and electronic component coating industries due to its large surface area per unit mass, small diameters (lower than 100nm) and small pore size [1, 2].

Nanofibers are more efficiently produced using electrospinning method, it's very simple and versatile technique compare to other methods. In this process nanofibres are generated in the presence of an electric field from a different polymer solution. This nanofiber has a number of outstanding properties such as high surface area, light weight and high porosity [3]. There are several parameters that can significantly influence the properties, formation and structure of produced nanofibers. These parameters are generally divided into three groups such as, a).Solution parameters: Viscosity, Concentration, Molecular weight of the polymer, Solvent properties, and Conductivity. b). Processing Parameters: Voltage applied, Distance of the electrode from the collector, Flow rate, and Capillary geometry. c). Environmental parameters: Temperature, and Relative humidity [4, 5].

Polyvinly alcohol (PVA) is a water soluble and biodegradable polymer and is considered as a good candidate for fabrication of composites containing cellulose nanofiber. PVA is not known to occur as a natural product. It will be produced by polymerization of polyvinyl acetate (PVAc) with Alcohol. It is used as a moisture barrier film for food supplement tablets [6].

Aloe vera is known as the oldest therapeutic herb and has the ability to promote wound healing as well as treat burn area on the skin. It contains two important layers in which the outer most layers is called vascular bundle and the inner layer is known as colorless parenchyma containing Aloe vera gel. Aloe vera has three compositions that include structural, chemical and polysaccharide. Polysaccharide plays the major role in promoting wound healing [7, 8]. It has wound healing

activity, antifungal activity, anti-diabetic effects, anti-inflammatory, anticancer, immunomodulatory and gastro protective properties [9]. Due to this properties it has many applications in various filed such as in the food industry its used for the production of health drinks, in the cosmetic and toiletry industry its used as base the production creams and lotions, in the pharmaceutical industry its used for the production of tropical ointments and this aloe vera gel may be employed to effectively deliver poorly absorbable drugs through the oral route of drug administration [10, 11].

Cynodon dactylon, is hard and rapidly growing grass. It possess various medicinal properties such as anti-inflammatory, diuretic, antiemetic, anti-diabetic, cardio protective effect, and blood purifying agent [12, 13]. *Cynodon Dactylon* will reduce the toxicity levels in the blood and it will not transfer to the liver and then kidney. The whole plant extract act as the blood purifier so that automatically reduces the side effects due to chemotherapy [14, 15].

This study is mainly focusing on the synthesis and characterization of nanofiber using naturally available materials like *Aloe Barbadensis* (Aloe vera) and *Cynodon dactylon* (arugampul).

2. MATERIALS AND METHODS

2.1. Materials

Aloe Barbadensis (Aloe vera) and *Cynodon dactylon* (arugampul) were collected from the campus of Government College of Technology, Coimbatore. PVA (Poly Vinyl Alcohol cold water soluble) was purchased from himedia laboratory Mumbai.

2.2. Sample preparation

Initially aloe vera and arugampul were taken and cleaned with water to remove the impurities deposited on it. The rind part of the aloe vera was removed and gel was separated from it. The gel was cleaned to remove yellow waxy substances and finally grinded using blender and filtered to get clear gel. Arugampul was grinded using blender and filtered to get the clear juice. 10g of PVA powder was dissolved in 100mL of cold distilled water (10 % w/v). The solution was stirred at 60˚C for 4hrs using magnetic stirrer to get homogenous clear solution. Three samples were prepared in the ratio of Sample 1- PVA+ arugampul + aloe vera (8:1:1), Sample 2 - PVA+ aloe vera + (3:1), Sample 3 – PVA + arugampul (5.5:1).

2.3. Electrospinning process

Electrospinning was done out using a high-voltage DC power supply in which the positive electrode was connected to the 5 mL syringe solution containing a mixture of aloe vera, arugamul and PVA. Similarly, the negative electrode was connected to the syringe needle that was used as the nozzle. The metal plate wrapped with aluminium foil was connected with grounded electrode. The tip of the needle and ground collector were placed horizontally facing each other. During the electrospinning process, the solution (PVA+ arugampul + aloe vera) were carefully loaded inside the syringe and the pressure was applied on top of the syringe to maintain a steady flow of polymer solution from capillary needle [16].

The voltage was applied at 25 kV across the distance of 15 cm between the tip of the needle and aluminium collector. The feed rate was controlled at 0.5 ml/h and the solution was electrospun for about1 hour and 7 hours in order to produce a long nanofiber. Finally, the nanofibres were removed from the collector and placed in the oven overnight at 37˚C [17, 18].

2.4. Scanning Electron Microscopy (SEM)

Scanning electron microscopy (SEM) was used to study the surface morphology of the compounds. FEI-Quanta 250 Scanning electron microscopy was used to take micrographs at voltage 20kV and at different scales (1µm, 0.5µm, 0.2µm)

2.5. Stability test

The weight stability of the nanofiber was tested through the stability test. Initially electrospun fiber was peeled from the aluminium foil and it was like a thin tissue paper. It was weighed and soaked in distilled water. The weight of the fiber was tested at a particular time interval.

This test describes the degradability of the fiber in the distilled water and the weight stability was calculated using the formula: [17]

$$S\ (\%) = \{(W_1 - W_2) / W_1\} * 100 \qquad (1)$$

Where,

W_1-weight of the dried film before experiment.
W_2-weight of the dried film after experiment.

3. RESULT AND DISCUSSION

The nanofibers were produced when electrospinning method was followed. Fig. 1 is the images of the electrospinning process being done and the final product respectively.

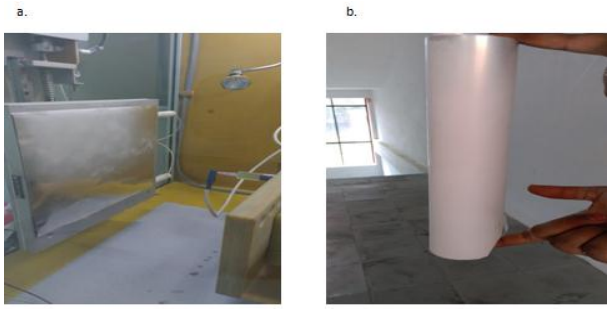

Fig. 1: a) Eletrospinning process, b) Nanofiber sheet

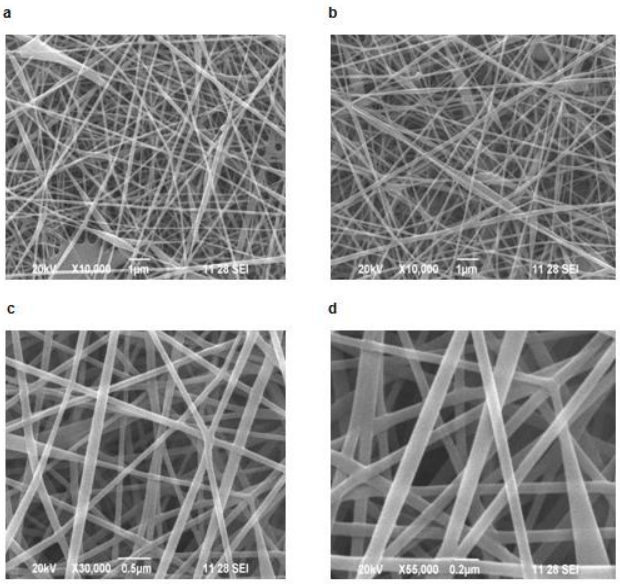

Fig. 2: SEM Images
(a)Aloe vera, Bermuda grass and PVA at 1µm scale,
(b) Aloe vera and PVA at 2µm scale,
(c) Aloe vera, Bermuda grass and PVA at 0.5µm scale
(d) Aloe vera, Bermuda grass and PVA at 0.2µm scale

The nanofiber was produced by electrospinning method and characterization of the nanofiber was done by Scanning electron microscope at 20kV and at different scales (1µm, 0.5µm, 0.2µm) and the stability of the nanofiber was found by the stability test. Fig. 2a is the SEM image of the nanofiber containing aloe vera, Bermuda grass and PVA at 1µm scale and Fig. 2b is the SEM image of the nanofiber containing aloe vera and PVA at 2µm. By analyzing both the images it is known that the bead formation is comparatively less in the Fig. 2a when compared to Fig. 2b. Based on the comparative studies the sample containing aloe vera, Bermuda grass and PVA for the further analysis. Fig. 2c and 2d are the SEM images of the sample containing aloe vera, Bermuda grass and PVA at 0.5µm and 0.2µm respectively.

From the stability test, Nanofiber spun for 1 hour had the weight of the dried fiber before and after the experiment was found to be 0.07 g and 0.05 g respectively. Percentage of stability is found to be 40%. And Nanofiber spun for 7 hours had the weight of the dried fiber before and after the experiment was found to be 0.31 g and 0.12g respectively. Percentage of stability is found to be 61.29 % using (1). Therefore it can be concluded from the solubility test that as the duration of the electrospinning process is increased the stability of the nanofibers also increases (i.e.) the stability of the nanofiber is directly proportional to the duration of electrospinning.

4. CONCLUSION

Thus the Nanofibers are produced by electrospinning method where sample 1 and 2 produce nanofiber but sample 3 does not produce the nanofiber because it does not produce the viscous solution. Then the nanofibers were characterized by the SEM analysis. From the SEM analysis it was found that the nanofiber with aloe vera, Bermuda grass and PVA sample 1 contains fewer beads due to its consistency compared to the sample 2. The stability test was performed to determine the percentage of stability of the nanofibers. It was found that as the duration of electrospinning process is increased the stability of the nanofiber increases. Finally we concluded that nanofiber produced by sample 1 can be used in targeted drug delivery [19] and absorption process [20] because of its size, high surface area, light weight and high porosity.

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REFERENCES

[1] C.P. Poole, F.J. Owens, *Introduction to Nanotechnology*, Wiley, 2005.
[2] Silva, Gabriel, Introduction to Nanotechnology and its applications to medicine, *Surgical Neurology*, 61, 2004, 216-20.
[3] N.A. Abdullah Shukry, K. Ahmad Sekak, M.R. Ahmad, T.J. Bustami Effendi, Characteristics of Electrospun PVA-Aloe vera Nanofibres Produced

via Electrospinning, *Proceedings of the International Colloquium in Textile Engineering, Fashion, Apparel and Design*, 2014.

[4] L. Weng, J. Xie, Smart Electrospun Nanofibers for Controlled Drug Release: Recent Advances and New Perspectives, *Current Pharmaceutical Design*, 21, 2015, 1944-1959.

[5] T. Subbiah, G.S. Bhat, R.W. Tock, S. Parameswaran, S.S. Ramkumar, Electrospinning of Nanofibers, *Journal of Applied Polymer Science*, 96, 2005, 557–569.

[6] S.K. Saxena, Polyvinyl Alcohol (PVA), 61st JECFA - Chemical and Technical Assessment (CTA), 2004, 1-3.

[7] M. Itrat, Zarnigar, Aloe Vera: a review of its clinical effectiveness, *International Research Journal of Pharmacy*, 4(8), 2013, 75-79.

[8] A. Surjushe**,** R. Vasani, D.G. Saple, Aloe vera: A short review, *Indian Journal of Dermatology*, 53 (4), 2008, 163-166.

[9] J.H. Hamman, Composition and Applications of Aloe vera Leaf Gel, *Molecules*, 13, 2008, 1599-1616.

[10] A.A. Channa, I.H. Qazi, S.A. Soomro, A.H. Shah, J.A. Gandahi, R.A. Korejo, I.A. Shah, N.A. Kalhoro, B. Khaskeli, Effect of oral supplementation of Aloe vera extract on haematology indices and immune cells of blood in rabbit, *African Journal of Pharmacy and Pharmacology*, 8(19), 2014, 497-501.

[11] F. Sabbadin Zanuzzo, J. Dalbello Biller-Takahashi1, E. Criscuolo Urbinati, Effect of Aloe vera extract on the improvement of the respiratory activity of leukocytes of matrinxa during the transport stress, *Revista Brasileira de Zootecnia*, 41(10), 2012, 2299-2302.

[12] A. Ramezani Kakroodi, S. Cheng, M. Sain, A. Asiri, Mechanical, Thermal, and Morphological Properties of Nanocomposites Based on Polyvinyl Alcohol and Cellulose Nanofiber from Aloe vera Rind, *Journal of Nanomaterials*, 2014, 903498.

[13] A. Asthana, A. Kumar, S. Gangwar, J. Dora, Pharmacological Perspective of *Cynodon dactylon*, *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 3(2), 2012, 1135-1147.

[14] S. Marappan, A. Subramaniyan, Antitumor Activity of Methanolic Extract of *Cynodon Dactylon* Leaves Against Ehrlich Ascites Induced Carcinoma In Mice, *Journal of Advanced Scientific Research*, 3(1), 2012, 105-108.

[15] S.K. Singh, P.K. Rai, S. Mehta, R.K. Singh, G. Watal, Curative effect of *Cynodon dactylon* against STZ induced hepatic injury in diabetic rats, *Indian Journal of Clinical Biochemistry*, 24 (4), 2009, 410-413.

[16] S. Haider, S.Y. Park, Preparation of the electrospun chitosan nanofibers and their applications to the adsorption of Cu(II) and Pb(II) ions from an aqueous solution, *Journal of Membrane Science*, 328, 2008, 90-96.

[17] P. Rita, M. Aninda, D.K. Animesh, An updated overview of *Cynodondactylon*(L.), *International Journal of Research*, 3 (1), 2012, 11-14.

[18] Logaranjan, Kaliyaperumal and Devasena, Thiyagarajan & Kannaiyan, Pandian, Quantitative Detection of Aloin and Related Compounds Present in Herbal Products and Aloe vera Plant Extract Using HPLC Method, *American Journal of Analytical Chemistry*, *4*, 2013, 600 - 605.

[19] J. Hrib, J. Sirc, R. Hobzova, Z. Hampejsova, Z. Bosakova, M. Munzarova, J. Michalek, Nanofibers for drug delivery – incorporation and release of model molecules, influence of molecular weight and polymer structure, *Beilstein Journal Nanotechnology*, 6, 2015,1939–1945.

[20] V. Andreu, G. Mendoza, M. Arruebo, S. Irusta**,** Review Smart Dressings Based on Nanostructured Fibers Containing Natural Origin Antimicrobial, Anti-Inflammatory, and Regenerative Compounds, *Materials*, 8, 2015, 5154-5193.