NAAC SSR Criterion 3.4.3

(Research papers published
(2019-2024)

Name of the Faculty	Qualification	No. of papers published (2019-2024)
Prof. Rabia Hamid	**PhD**	19
Dr. Mushtaq A. Beigh	**PhD**	14
Dr. Faheem A. Sheikh	**PhD**	48
Dr. Shafquat Majeed	**PhD**	06
Dr. Tariq Maqbool	**PhD**	06

List of Publications

1. Hasham Shafi, Rumaisa Rashid, Sami-ullah Rather, DV Siva Reddy, Lubna Azmi, Abdalla Abdal-hay, Salman H Alrokayan, Haseeb A Khan, Nisar Ahmad Khan, Faheem A Sheikh*, Super disintegrating oromucosal nanofiber patch of zolmitriptan for rapid delivery and efficient brain targeting, Chemical Engineering Journal, ISSN: 1873-3212, DOP: 2023/5/1, DOI: 10.1016/j.cej.2023.142481, (2023), 463,142481 (IF=15.1).
2. Hasham S Sofi, Abdalla Abdal-hay, Rumaisa Rashid, Asma Rafiq, Sami-ullah Rather, Mushtaq A Beigh, Salman H Alrokayan, Haseeb A Khan, Ravi Mani Tripathi, Faheem A Sheikh*, Electrospun polyurethane fiber mats coated with fish collagen layer to improve cellular affinity for skin repair, Sustainable Materials and Technologies, ISSN: 2214-9937, DOP: 2022/12/1. DOI: 10.1016/j.susmat.2022.e00523 (2022) 34, e00523 (IF=9.6).
3. Hamid B, Bhat MH, Majid S, Hamid R. 2022. Elucidation of early markers in Insulin resistance Diabetes patients of Kashmir Valley. Metabolism 128 (Supplement March 2022): 155106 https://doi.org/10.1016/j.metabol.2021.155106 Impact Factor: 8.694
4. Rafiq A, Aashaq S, Jan I, Ali M, Rakshan R, Bashir A, Haq E and Beigh MA*. GSK3β phosphorylates Six1 transcription factor and regulates its APC/CCdh1 mediated proteosomal degradation. Cellular Signalling, 2023 Dec, 115; 111030 (IF: 4.8).
5. Hasham Shafi, DV Siva Reddy, Rumaisa Rashid, Trisha Roy, Shabnam Kawoosa, GN Bader, JVUS Chakradhar, Abdalla Abdal-Hay, Mushtaq A Beigh, Shafquat Majeed, Nisar Ahmad Khan, Faheem A Sheikh*, Optimizing the fabrication of electrospun nanofibers of prochlorperazine for enhanced dissolution and permeation properties, Biomaterials Advances, ISSN: 2772-9508, DOP: 2024/4/1, DOI: https://doi.org/10.1016/j.bioadv.2024.213773, (2024); 258: 213773 (IF=7.9).
6. Muheeb Rafiq, Sami-ullah Rather, Taha Umair Wani, Anjum Hamid Rather, Rumysa Saleem Khan, Anees Ellahi Khan, Ibtisam Hamid, Haseeb A Khan, Abdullah S Alhomida, Faheem A Sheikh*, Recent progress in MXenes incorporated into electrospun nanofibers for biomedical application: Study focusing from 2017 to 2022, Chinese Chemical Letters, ISSN: 1001-841, DOP: 2023/4/18 (2023), 34, 108463 (IF=9.1).
7. Anees S, Manzoor I, Fatima K, Ganie SA Hamid R.* 2023. GCMS analysis and potential therapeutic efficacy of extracts from Allium humile in lowering Dyslipidemia in wistar rat models. Journal of Ethnopharmacology 320 (2024) 117478. Impact Factor: 5.4
8. Rafiq A, Aashaq S, Jan I, Beigh MA*. SIX1 transcription factor: A review of cellular functions and regulatory dynamics. Int J Biol Macromol. 2021 Dec 15;193(Pt B):1151-1164 (IF: 8.4)
9. Anees S, Ganie SA, Hamid R.* 2024. Bioactive fractions from Allium humile alleviate the risk of High fat diet induced Atherosclerosis in Albino Wistar rats by inhibiting Protein Kinase C Fitotherapia 172 (2024) 105775 doi: 10.1016/j.fitote.2023.105775. Impact Factor: 3.4
10. Bashir H, Majid S, Khan MS, Bhat MH, Hamid R, Ashraf R, Faiz S. 2022. Inter-relationship of Pro- and Anti-inflammatory Biomarkers with the development of Type 2 Diabetes Mellitus Heliyon 31; 8(11): 1-11 e11329. doi: 10.1016/j.heliyon.2022.e11329. Impact Factor: 3.776
11. Ali R, Mir HA, Hamid R, Bhat B, Shah RA, Khanday FA, Bhat SS. 2022. Actin modulation regulates the Alpha-1-Syntrophin/p66Shc mediated redox signaling contributing to the RhoA GTPase protein activation in breast cancer cells Frontiers in Oncology: Cancer Molecular Targets and Therapeutics 12: 841303 doi: 10.3389/fonc.2022.841303 Impact Factor: 5.738
12. Bashir R, Zargar O, Malik AH, Hamid R.* 2022. Apoptosis inducing effects of Thymus linearis methanolic extract in HCT-116 cells and LC-MS chemical profiling of its active constituents Natural Products Journal 12(4): 64-75 Impact Score: 1.2
13. Bashir R, Zargar OA, Parvaiz Q, Hamid R.* 2021. The modulation of PI3K/Akt pathway by 3β hydroxylup-12-en-28-oic acid isolated from Thymus linearis induces cell death in HCT-116 cells. Chemical Biology & Drug Design. 99:162–178. Impact factor: 2.873

List of Publications

14. Ali R, Mir HA, Hamid R, Shah RA, Khanday FA, Bhat, SS. 2021. Jasplakinolide Attenuates Cell Migration by Impeding Alpha-1-syntrophin Protein Phosphorylation in Breast Cancer Cells. The Protein Journal. 40: 234–244. Impact Factor: 4.0
15. Zargar O, Bashir R, Zargar MA, Hamid R*. 2021. COVID-19 Pandemic: Current Scenario, Challenges and Future Perspectives Coronavirues. 2(8):1-16.
16. Hassan S, Bhat MA, Sajjad N, Ali R, Ganie SA, Hamid R*. 2020. Hepatoprotective effects of Meconopsis aculeata extract against CCl4 induced oxidative damage in rats. Advances in Traditional Medicine, 2020(3):1-6. Impact Factor: 1.34
17. Sofi HS, Rashid R, Amna T, Hamid R, Sheikh FA (2020) Recent advances in formulating electrospun nanofiber membranes: Delivering active phytoconstituents. Journal of Drug Delivery Science and Technology. 60(2020):1-17. Impact Factor: 3.981
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19. Hassan S, Sajjad N, Khan SU, Gupta S, Bhat MA, Ali R, Ahmed Z, Ganie SA, Hamid R*. 2020. Dipsacus inermis Wall. modulates inflammation by inhibiting NF-κB pathway: An in vitro and in vivo study. Journal of Ethnopharmacology. 254(2):11270. Impact Factor = 5.4
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21. Sajjad N, Wani A, Hassan S, Ali R, Hamid R*, Akbar S, Ganai BA and Bhat EA. 2019. Interplay of antioxidants in Alzheimer's disease. Journal of Translational Science. 5:1-11. Impact Factor: 2.12
22. Sajjad N, Wani A, Sharma A, Ali R, Hassan S, Hamid R, Habib H, Ganai BA. 2019. Artemisia amygdalina Upregulates Nrf2 and Protects Neurons Against Oxidative Stress in Alzheimer Disease. Cellular and Molecular Neurobiology. 39(3):387-399. Impact Factor: 4.3
23. Rumysa Saleem Khan, Anjum Hamid Rather, Taha Umair Wani, Muheeb Rafiq, Somia Abd Alla Mohammed El Hassan, Touseef Amna, Sami-ullah Rather, Arvind H Jadhav, Syed Mudasir Ahmad, Faheem A Sheikh*. Comparative study on silver nanoparticles adsorption by ultrasonication and hydrothermal approaches on β-cyclodextrin incorporated polyurethane micro-nanofibers as multifunctional tissue engineering candidate. Progress in Organic Coatings. ISSN: 0300-9440, DOP: 2024/2/1, DOI: 10.1016/j.porgcoat.2023.108144. (2024); 187:108144. (IF=6.2).
24. Rumysa Saleem Khan, Aaliya Qureashi, Muheeb Rafiq, Anjum Hamid Rather, Mudasir Manzoor Reshi, Abrar Qurashi, Ravi Mani Tripathi, Faheem A Sheikh*, Silk fibroin-copper nanoparticles conglomerated polyurethane fibers incorporating calcium carbonate for enhanced fluid retention, antibacterial efficacy and promotion of cell growth, Journal of Drug Delivery Science and Technology, DOP: 2024/2/22, DOI: https://doi.org/10.1016/j.jddst.2024.105464(2024): (2024) : 105464 (IF=5.0).
25. Muheeb Rafiq, Anjum Hamid Rather, Rumysa Saleem Khan, Taha Umair Wani, Haseeb A Khan, Abdullah S Alhomida, Faheem A Sheikh*, Magnesium-reinforced Electrospun Synthetic-polymer Nanofibers Designed for Promoting Tissue Growth, Journal of Bionic Engineering, ISSN: 2543-2141, DOP: 2024/3/26, DOI: https://doi.org/10.1007/s42235-024-00495-6, (2024): 2543-2141 (IF=4.1).
26. Anjum Hamid Rather, Rumysa Saleem Khan, Taha Umair Wani, Muheeb Rafiq, Aaliya Qureashi, Sami-ullah Rather, M Hemavathi, Arvind H Jadhav, Shafquat Majeed, Faheem A Sheikh*. Hydrothermal Modification of Polyurethane Fibers Using Hyaluronic Acid and Silver Nanoparticles for Wound Healing. Journal of Polymers and the Environment. ISSN: 1572-8919, DOP: 2024/1/11, DOI: 10.1007/s10924-023-03146-9. (2024),1-20. (IF=5.3).
27. Anjum Hamid Rather, Rumysa Saleem Khan, Taha Umair Wani, Muheeb Rafiq, Arvind H Jadhav, Puneethkumar M Srinivasappa, Abdalla Abdal-Hay, Phalisteen Sultan, Sami-ullah Rather, Javier Macossay, Faheem A Sheikh*,

Polyurethane and cellulose acetate micro-nanofibers containing rosemary essential oil, and decorated with silver nanoparticles for wound healing application, International Journal of Biological Macromolecules, ISSN: 1879-0003, DOP: 2023/1/31, DOI: 10.1016/j.ijbiomac.2022.12.048, (2023), 226, 690-705 (IF=8.2).

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29. Taha Umair Wani, Anjum Hamid Rather, Rumysa Saleem Khan, Javier Macossay, Arvind H Jadhav, Puneethkumar M Srinivasappa, Abdalla Abdal-hay, Sami-ullah Rather, Faheem A Sheikh*, Titanium dioxide functionalized multi-walled carbon nanotubes, and silver nanoparticles reinforced polyurethane nanofibers as a novel scaffold for tissue engineering applications, Journal of Industrial and Engineering Chemistry, ISSN: 0095-9014, DOP: 2023/1/23, DOI: 10.1016/j.jiec.2023.01.024 (2023) 121, 200-214 (IF=6.1).
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31. Muheeb Rafiq, Rumysa Saleem Khan, Taha Umair Wani, Anjum Hamid Rather, Touseef Amna, M Shamshi Hassan, Sami-ullah Rather, Faheem A Sheikh*, Improvisations to electrospinning techniques and ultrasonication process to nanofibers for high porosity: Ideal for cell infiltration and tissue integration, Materials Today Communications, ISSN 2352-4928, DOP: 2023/2/24 DOI: 10.1016/j.mtcomm.2023.105695 (2023), 38, 105695, (IF=3.8).
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37. Muheeb Rafiq, Rumysa Saleem Khan, Anjum Hamid Rather, Taha Umair Wani, Aaliya Qureashi, Altaf Hussain Pandith, Sami-ullah Rather, Faheem A Sheikh*, Overview of printable nanoparticles through inkjet process: Their application towards medical use, Microelectronic Engineering, ISSN: 0167-9317, DOP: 2022/9/27, DOI: https://doi.org/10.1016/j.mee.2022.111889 (2022) 226, 111889 (IF=2.3).
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51. Roqia Ashraf, Hasham S. Sofi, Mushtaq A Beigh, Faheem A. Sheikh*, "Recent trends in peripheral nervous regeneration using 3D biomaterials", Tissue and Cell, ISSN:0040-8166, DOP: 01-08-2019, DOI: 10.1016/j.tice.2019.06.003, 59, 70-81 (2019) (IF=2.6)
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GC-MS analysis and potential therapeutic efficacy of extracts from Allium humile Kunth in lowering dyslipidemia in wistar rat models

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Full text links

Cite

Abstract

Ethnopharmacological relevance: Small Alpine onion Allium humile (Alliaceae) is a common traditional Indian medicine used for blood purification, anti-inflammatory, anti-asthmatic, anti-diabetic and seasoning agents. It is also used for the treatment of asthma, jaundice, stomach problems, cardiovascular disorders and anti-cancer agent.

Aim of the study: In this study, various extracts from the A. humile were taken and their therapeutic activity against dyslipidemia was evaluated in wistar rat models.

Materials and methods: The extraction was done by Soxhlet extraction and the extracts (hexane, ethyl acetate, methanol, ethanol and aqueous) obtained were then tested for nitric oxide radical scavenging activity. The effective extracts i.e., methanol and ethyl acetate were then selected for in vivo studies in wistar rats. Dyslipidemia was induced in rats by feeding them high fat diet, and extracts of varying concentrations were administered to assess their potential for decreasing dyslipidemia. Statin was used as a positive control. After treatment, the blood was drawn and serum was separated for tests such as lipid profile, atherogenic index, lipid peroxidation and histopathological study. GC-MS analysis was carried out to identify the types of compounds present in A. humile extracts and FTIR analysis of extracts was done to determine the types of chemical bonds and functional groups.

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Bioactive fractions from Allium humile alleviate the risk of high fat diet induced atherosclerosis in albino Wistar rats by inhibiting protein kinase C

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Full text links

Cite

Abstract

Atherosclerosis is a global concern that worsens with age, and plants that are effective medicinal herbs can give a viable alternative. PKC is a key factor in cardiovascular and other disorders; targeting it can reduce the risk of these diseases. We evaluated Allium humile for PKC inhibition and therapeutic efficacy against atherosclerosis. Soxhlet extraction was done to obtain extracts (hexane, ethyl acetate, methanol, ethanol and aqueous) and then tested for DPPH radical scavenging and PKC inhibitory activity. The methanolic extract was more active than the other extracts, so it was subjected to column chromatography, and seventeen fractions were obtained. Only 11, 12, and 15 showed good activity against PKC. Wistar rats were divided into six groups and each group received high fat diet for 30 days. Then the three potent fractions (10 mg/kg) were administered for 15 days along with high fat diet. Fraction II had the highest effectiveness ($P < 0.0001$) in decreasing lipid levels, lipid peroxidation, reducing IL-6 and TNF-α expression, and raising nitric oxide. This also demonstrated a decrease in PKC activity, as well as a decrease in the formation of the lipoidal layer in the aorta wall and rupture of the intima and media as validated by

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Research article

Inter-relationship of Pro- and Anti- inflammatory Biomarkers with the development of Type 2 Diabetes Mellitus

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Interleukin-10
IL-10

ABSTRACT

Purpose: There has been growing evidence that inflammatory markers play a role in the development as well as severity of Type 2 diabetes mellitus (T2DM). This study has been designed to decipher the involvement of C-Reactive Protein (CRP), Tumor Necrosis Factor (TNFα), Interleukin-6 (IL-6) and Interleukin-10 (IL-10) in the etiopathogenesis of T2DM.
Basic procedures: A total of 460 T2DM cases and 540 healthy controls were recruited for the study. Blood samples were collected from each study subject to measure the serum levels of CRP, TNFα, IL-6 and IL-10.
Main findings: We found that serum levels of CRP in mg/dl (4.2 ± 0.5), TNFα in pg/ml (34.5 ± 8.8), IL-6 in pg/ml (19.2 ± 7.2) in T2DM patients were significantly high as compared to control participants (CRP; 1.4 ± 0.6, TNFα; 12.7 ± 3.4, IL-6; 3.1 ± 1.4; P < 0.0001). The serum levels of IL-10 in pg/ml were lower in T2DM cases compared to controls (4.35 ± 1.2 vs. 9.6 ± 1.2). In addition, we observed a significant association of CRP levels with insulin resistance, obesity and dyslipidemia. Increased TNFα levels were strongly associated with female gender, Poor glycemic control and strong family history of diabetes. Poor glycemic control was significantly associated with elevated IL-6 levels. Moreover, significantly reduced IL-10 levels were found in T2DM patients with sedentary lifestyle, low educational and rural background.
Conclusions: This study showed a strong relationship between TNFα, IL-6, CRP, IL-10 and T2DM patients of Kashmiri ethnicity, treated at SMHS Hospital. Thus, supporting other studies and showing that cytokines may be good markers for T2DM development.

1. Introduction

Type 2 Diabetes Mellitus (T2DM) is a group of genetically determined diseases which may be controlled by diet and/or hypoglycemic agents and/or exogenous insulin [1,2]. It accounts for about 90%–95% of all diagnosed cases of diabetes. T2DM, previously referred to as non–insulin dependent diabetes or adult-onset diabetes, encompasses individuals who have insulin resistance and usually have relative insulin deficiency towards later stages [3]. T2DM is recognized as a serious public health concern with a considerable impact on human life and health expenditures. Rapid economic development and urbanization have led to a rising burden of diabetes in many parts of the world [4]. T2DM affects individuals' functional capacities and quality of life, leading to significant morbidity and premature mortality [5].

T2DM for the entire world is not an epidemic anymore but has covered into pandemic. Globally, an estimated 537 million adults aged 20–79 years are currently living with diabetes. The total number is predicted to rise to 643 million (11.3%) by 2030 and to 783 million (12.2%) by 2045 [6]. As far as human suffering (DALYs - Disability-Adjusted Life Years) are concerned, diabetes ranks as the 7th leading disease [7].

Among the countries of south-east Asia, India has highest number of people with diabetes in the age group of 20–79 years accounting to 74.2 million in 2021 with an age adjusted prevalence of 9.6%. There are estimated 39.4 million undiagnosed cases of diabetes in India as of 2021.

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PMCID: PMC9641208 | PMID: 36387548

Inter-relationship of Pro- and Anti- inflammatory Biomarkers with the development of Type 2 Diabetes Mellitus

Haamid Bashir,[a,1] Sabhiya Majid,[a,*,1] Mosin Saleem Khan,[a,b,1] Mohammad Hayat Bhat,[c] Rabia Hamid,[d] Roohi Ashraf,[a] and Sunia Faiz[a]

Associated Data

▸ Supplementary Materials

ORIGINAL RESEARCH article

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Actin Modulation Regulates the Alpha-1-Syntrophin/p66Shc Mediated Redox Signaling Contributing to the RhoA GTPase Protein Activation in Breast Cancer Cells

Roshia Ali[1,2] Hilal Ahmad Mir[1] Rabia Hamid[3] Basharat Bhat[4]
Riaz A. Shah[5] Firdous A. Khanday[1*] Sahar Saleem Bhat[5*†]

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SNTA1 signaling axis plays an essential role in cytoskeletal organization and is also implicated in breast cancers. In this study, we aimed to investigate the involvement of actin cytoskeleton in the propagation of SNTA1/p66shc mediated pro-metastatic cascade in breast cancer cells.The effect of actin filament depolymerization on SNTA1-p66Shc interaction and the trimeric complex formation was analyzed using co-

Metabolism
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Elucidation of early markers in Insulin resistance Diabetes patients of Kashmir Valley

Haamid Bashir • Mohammad Hayat Bhat • Sabhiya Majid • Rabia Hamid

DOI: https://doi.org/10.1016/j.metabol.2021.155106

Diabetes Mellitus Type 2 (T2DM) is a complex, non-communicable disease. It is the biggest cause of death in children under the age of five in the world. Inflammatory cytokines have been shown to increase insulin resistance and, as a result, T2DM. The goal of this study was to look at the involvement of inflammatory mediators such as Tumor Necrosis Factor (TNF-) and White Blood Cells (WBCs) in mobilizing biological molecules, particularly those of an immunological origin and its possible role in the Insulin resistance. This study included 520 participants, 260 of whom had T2DM and 260 of whom were healthy controls. TNF-a (Tumor Necrosis Factor-a) concentrations in the blood were analysed using an ELISA approach, WBC count was determined using a Sysmax (Germany) hematology analyzer, and biochemical and immunoassay parameters were determined using fully automatic analyzers. T2DM patients had higher levels of potential pro-inflammatory cytokine (TNF-), as well as (WBC's).

> Chem Biol Drug Des. 2022 Jan;99(1):162-178. doi: 10.1111/cbdd.13957. Epub 2021 Oct 26.

The modulation of PI3K/Akt pathway by 3β hydroxylup-12-en-28-oic acid isolated from Thymus linearis induces cell death in HCT-116 cells

Rohina Bashir [1], Ovais Ahmad Zargar [1], Abid Hamid Dar [2], Nalli Yedukondalu [3], Qazi Parvaiz [4], Rabia Hamid [5]

Affiliations + expand

PMID: 34558199 DOI: 10.1111/cbdd.13957

Full text links

Cite

Abstract

The presence of intricate carbon skeletons in natural compounds enhances their bioactivity spectrum with unique modes of action at several targets in various dreadful diseases like cancer. The present study was designed to purify the molecules from Thymus linearis and elucidate their antiproliferative activity. The compounds were isolated from the active methanolic extract of Thymus linearis through column chromatography and characterized by various spectroscopic techniques. Antiproliferative activity of isolated compounds was evaluated using MTT assay on cancer and normal cell lines. Mechanism of cell death was elucidated using flow cytometric, microscopic, and Western blot analysis. Four compounds, Sitosterol, Chrysin, 3β-hydroxylup-12-en-28-oic acid (3BH), and β-Sitosterol glycoside, were isolated. Among these, 3BH was most potent antiproliferative agent across all cell lines under study, HCT-116 being the most affected one. 3BH was demonstrated to downregulate PI3Ksubunits (p110α and p85α), downstream $pAktSer^{473}$ and prompted G_1 phase cell cycle arrest. The cell cycle CDK inhibitor p27 and p21 were upregulated with simultaneous downregulation of cyclin D1 and cyclin E in HCT-116 cells. This was accompanied by apoptosis, as depicted by decrease in Bcl-2/Bax ratio, with increase in active caspases-3 and caspase-9, cleavage of PARP-1, the generation of reactive oxygen species (ROS), and the loss of mitochondrial membrane potential. The findings established that 3BH induced

> Protein J. 2021 Apr;40(2):234-244. doi: 10.1007/s10930-021-09963-y. Epub 2021 Jan 30.

Jasplakinolide Attenuates Cell Migration by Impeding Alpha-1-syntrophin Protein Phosphorylation in Breast Cancer Cells

Roshia Ali [1, 2], Hilal Ahmad Mir [1], Rabia Hamid [3], Riaz A Shah [4], Firdous A Khanday [5], Sahar Saleem Bhat [6]

Affiliations + expand

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Cite

Abstract

Background: Alpha-1-syntrophin (SNTA1) is emerging as a novel modulator of the actin cytoskeleton. SNTA1 binds to F-actin and regulates intracellular localization and activity of various actin organizing signaling molecules. Aberration in syntrophin signaling has been closely linked with deregulated growth connected to tumor development/metastasis and its abnormal over expression has been observed in breast cancer. In the present work the effect of jasplakinolide, an actin-binding cyclodepsipeptide, on the SNTA1 protein activity and SNTA1 mediated downstream cellular events was studied in MDA-MB-231 breast cancer cell line.

Methods: SNTA1 protein levels and phosphorylation status were determined in MDA-MB-231 cells post jasplakinolide exposure using western blotting and immunoprecipitation techniques respectively. MDA-MB-231 cells were transfected with WT SNTA1 and DM SNTA1 ($Y^{215/229}$ phospho mutant) and simultaneously treated with jasplakinolide. The effect of jasplakinolide and SNTA1 protein on cell migration was determined using the boyden chamber assay.

CHAPTER 5

Targeting Cancer Stem Cells: Implications in Health and Disease

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Abstract: Cancer is a serious global health concern as it accounts for about 9.6 million deaths worldwide. Despite striking breakthroughs made in understanding, prevention, and treatment of cancer, the mortality rate is still high and no permanent cure has been found. The major concern is the lack of effective therapies against advanced metastasis. Thus, there is a dire need to implement new treatment approaches to combat this dreadful disease. Cancer stem cells (CSCs), being critical players of tumors can be the potential target for therapy. Currently, cancer stem cell therapy is gaining much attention from researchers because of its ability to target the CSCs, which are responsible for tumor initiation, progression, metastasis, therapeutic resistance, and recurrence. While most conventional treatment strategies target fast-growing tumor cells, CSCs may remain in the latent stage for extended periods thereby escaping the traditional therapies and leading to treatment resistance. Hence, specific targeting of the tumor-initiating cells has become the heart of cancer research, aiming at the complete elimination of malignancies. Major strategies against CSCs include targeting surface CSC biomarkers, blockage of self-renewal signaling pathways (Wnt, Nanog, Hippo/YAP, Notch, PTEN, Hedgehog, and/or STAT3), genetic targeting of CSCs, cell therapy, RNA interference utilizing miRNAs. Based on this concept, the present chapter summarizes the current strategies and the lead molecules which have found their route to preclinical and clinical studies. Since the evolution of clinical trials targeting CSCs holds a sanguine promise of affecting cancer medicine. This chapter will further throw light on rapid advancement made in this field, shortcomings faced in targeting CSCs, and several critical issues that are yet to be resolved.

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Review article

Recent advances in formulating electrospun nanofiber membranes: Delivering active phytoconstituents

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ABSTRACT

Extracts derived from plant origin have been used in clinical practice for the management of burn injuries, wounds and different medical ailments, dating back many centuries. In current modern practice, the application of plant-based extracts has been extended to repair and/or regenerate soft to hard tissues using nanotechnology. Lately, the evolution of polymeric scaffolds by electrospinning technique has expanded the scope of plant-based extract in exploitation to various biomedical fields. In this work, an exhaustive literature survey was conducted out by means of scientific engines and databases such as Google Scholar, PubMed, ScienceDirect and MEDLINE. The articles published between 1933 and 2018 were included in this study to investigate the applicability of plant-based extracts using nanofibers as keywords. This review recapitulates the implementation and recent advances of plant extract incorporated in nanofibers for the domains of tissue engineering, drug delivery and wound healing. Furthermore, these scaffolds provide a high degree of porosity ensuing in the large surface area accessible for cell attachment and infiltration, gaseous/waste exchange and nutrient mobilization. These scaffolds also represent as mats to assist as skin graft replacement for proper application of the affected areas at burn sites. These scaffolds provide innovative means of encapsulating the phytoconstituents and additional options to synthetic replicas used in wound management and drug delivery. However, novel strategies need to be endorsed for large-scale generation of the fibers and succeeding in clinical translation of these outcomes.

1. Introduction

Plant-derived natural outcomes have been extensively used since ancient times for treating various diseases. In the era of contemporary medicine, herbal formulations are known to exert a positive influence on inflammation, fibroplasia, epithelization, collagenation and wound contraction [1–3]. The outcomes from medicinally significant herbs has led to the development of various pharmaceutical formulations intended for various ailments [4,5]. Recently, these products have also been employed in various advanced fields of tissue engineering including that of bone, nerve and skin regeneration [6–10]. Nevertheless, natural products have demonstrated to be extraordinarily efficacious in curing various disease and ailments. Therefore, many practitioners with experience in modern medicine have opted this preferred medication system to treat their patients with herbal remedies [11,12]. Moreover, it is approximately estimated that 25% of prescription drugs are either composed of medicinal plant extracts and/or plant-derived natural products [13]. Currently, the plant-based extracts have even been employed to treat prostate cancers and are commercially available [14]. Many techniques have been full-fledged to deliver herbal products inside the human body for treating different disorders. The traditional course of delivering these formulations include tablets [15], capsules [16], syrups [17], solutions [18] and decoctions [19], whereas, the modern procedures include mouth dissolving tablets [20], matrix tablets [21], microgranules [22], mucoadhesive systems [23], transdermal films [24], retentive buccal systems [25], aerosols [26], microparticles [27], microcapsules [28], nanoparticles [29], sustained release implants [30], nanomicellar systems [30] and colloidal nanogels [31].

In addition to these approaches, the contemporary focus is on the delivery of natural products to targeted disease sites, and the development of tissue engineering techniques to transform the current drug delivery system [32–34]. It is notable in mentioning that the challenge in the delivery of a natural product at a targeted site relies on attaining the ideal bioavailability. In this regard, the nanocarriers (e.g.,

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Available online 30 August 2020

Hepatoprotective effects of Meconopsis aculeata extract against CCl 4 induced oxidative damage in rats

October 2020 · Advances in Traditional Medicine 20(4)
DOI:10.1007/s13596-020-00490-2

Authors:

Sumaya Hassan · Muzaffar · Ahmad Bhat · Nasreena Sajjad · Rohaya Ali

· Showkat · Showkat Ganie · Rabia Hamid

Abstract and Figures

The objective of the present study was to investigate the hepatoprotective effects of methanol extract of Meconopsis aculeata, an important medicinal plant of Kashmir Himalayas, against CCl 4 induced oxidative damage in rats. Acute hepatotoxicity was induced in Wistar albino rats by single intraperitoneal injection of CCl 4 at 1 ml/kg body weight dose. Methanol extract of M. aculeata was orally administered at the doses of 100, 200 and 300 mg/kg body weight/day for 14 days. The results revealed that administration of CCl 4 caused a significant increase in serum AST, ALT and LDH levels as compared to the control group ($p < 0.001$). Additionally, there was a significant decrease in the level of hepatic GSH, GPx, GST, SOD and CAT activities associated with a significant increase of MDA content in CCl 4 treated group compared to those of the control group. However, the treatment with methanol extract of M. aculeata prevented these alterations and maintained the antioxi-dant status. The hepatoprotective property of the extract was further confirmed by histopathological analysis, wherein the extract was shown to prevent neutrophil infiltration and tissue necrosis in the liver

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Review article

Recent advances in formulating electrospun nanofiber membranes: Delivering active phytoconstituents

Hasham S. Sofi [a], Rumaisa Rashid [b], Touseef Amna [c], Rabia Hamid [a], Faheem A. Sheikh [a]

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Abstract

Extracts derived from plant origin have been used in clinical practice for the management of burn injuries, wounds and different medical ailments, dating back many centuries. In current modern practice, the application of plant-based extracts has been extended to repair and/or regenerate soft to hard tissues using nanotechnology. Lately, the evolution of polymeric scaffolds by electrospinning technique has expanded the scope of plant-based extract in exploitation to various biomedical fields. In this work, an exhaustive literature survey was conducted out by means of scientific engines and databases such as Google Scholar, PubMed, ScienceDirect and MEDLINE. The articles published between 1933

ELSEVIER

Toxicology Reports
Volume 7, 2020, Pages 370-375

toxicology reports

Genotoxic effect of two commonly used food dyes metanil yellow and carmoisine using *Allium cepa* L. as indicator

Ishfaq Shafi Khan [a], Md. Niamat Ali [a], Rabia Hamid [b], Showkat Ahmad Ganie [c]

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Highlights

- Genotoxic assay *via Allium cepa* was carried out with metanil yellow and carmoisine.
- They are azo dyes used in food and pharmaceutical products as coloring agents.
- *Allium cepa* is considered sensitive indicator of environmental chemicals.
- Result indicated genotoxic and cytotoxic effects by metanil yellow and carmoisine.

ELSEVIER

Journal of Ethnopharmacology

Volume 254, 23 May 2020, 112710

Dipsacus inermis Wall. modulates inflammation by inhibiting NF-κB pathway: An *in vitro* and *in vivo* study

Sumaya Hassan [a], Nasreena Sajjad [a], Sameer Ullah Khan [b], Shilpa Gupta [b], Muzaffar Ahmad Bhat [a], Rohaya Ali [a], Zabeer Ahmad [b], Showkat Ahmad Ganie [c], Rabia Hamid [a]

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Abstract

Ethnopharmacological relevance

Dipsacus inermis Wall. is an edible Himalayan herb which is extensively used in traditional Ayurvedic system of medicine against various inflammation related disorders.

Iran University of Medical Sciences MEDICAL JOURNAL OF THE ISLAMIC REPUBLIC OF IRAN

Med J Islam Repub Iran. 2020; 34: 5. Published online 2020 Feb 12. doi: 10.34171/mjiri.34.5

PMCID: PMC7139256 | PMID: 32284929

Role of inflammatory mediators (TNF-α, IL-6, CRP), biochemical and hematological parameters in type 2 diabetes mellitus patients of Kashmir, India

Haamid Bashir,[1] Showkat Ahmad Bhat,[2] Sabhiya Majid,[*1] Rabia Hamid,[3] Rakesh K Koul,[4] Muneeb U Rehman,[1] Insha Din,[1] Javaid Ahmad Bhat,[1] Jasiya Qadir,[1] and Akbar Masood[3]

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Abstract

Go to: ▸

Background: Type II Diabetes mellitus (T2DM) is a multifactorial disease and a leading cause of premature deaths. Inflammatory cytokines are reported that they have potential to enhance insulin resistance and hence T2DM. Assessment of immunological profile in T2DM patients of Kashmir valley is unclear. So, detection of cytokines is relevant to determine the extent and direction of immune responses. The current research was taken to study the role of inflammatory mediators in T2DM along with insulin sensitivity, biochemical and hematological parameters in mountainous valley of Kashmiri population.

Methods: A total of 340 subjects were selected in this study among them 160 were T2DM cas and 180 were healthy controls. Serum expression of inflammatory mediators (TNF-α and IL-6 were quantified by ELISA technique, WBC count was measured on Sysmax (Germany) hematology analyzer, biochemical and Immunoassay parameters were done on Abbott c4000 (USA) and Abbott C1000 (USA) fully automatic analyzer. Data was analyzed using statistical 'software SPSS 16.1' (Chicago, IL). For all assessments, $p<0.05$ were considered statistically significant.

Feedback

Interplay of antioxidants in Alzheimer's disease

Sajjad N · Wani A · Hassan S · Ali R · Hamid R · Akbar S · Ganai BA · Bhat EA

DOI: 10.15761/JTS.1000313

Abstract

The generation of reactive oxygen species (ROS) results in oxidative stress, leading to damage of tissue via many cellular molecular pathways. ROS can result in damage of principal cellular components of the cell such as lipids, proteins, and nucleic acids which then cause cell death via different modes of necrosis or apoptosis. Therefore, it is very important to maintain the redox status in our body. This is maintained by balance in the production of free radicals and antioxidants. Oxidative stress is the main phenomena which occur in progression of many diseases such as diabetes, neurodegenerative diseases, cancers etc. Alzheimer disease (AD) is one of the neurodegenerative disease and is common form of dementia in elderly people. The etiology of this disease is multifactorial; pathologically it is accompanied with accumulation of amyloid beta and neurofibrillary tangles. Accumulation of amyloid beta and mitochondrial dysfunction leads to oxidative stress. There is natural antioxidant defence system in our body which helps us to prevent us from various diseases via different mechanisms. Antioxidants are believed to act against the detrimental effects of ROS and thereby preventing or treating

> Cell Mol Neurobiol. 2019 Apr;39(3):387-399. doi: 10.1007/s10571-019-00656-w. Epub 2019 Feb 6.

Artemisia amygdalina Upregulates Nrf2 and Protects Neurons Against Oxidative Stress in Alzheimer Disease

Nasreena Sajjad [1], Abubakar Wani [2], Ankita Sharma [2], Rohaya Ali [1], Sumaya Hassan [1], Rabia Hamid [1], Huma Habib [3], Bashir Ahmad Ganai [4]

Affiliations + expand

PMID: 30725250 DOI: 10.1007/s10571-019-00656-w

Full text links   Cite

Abstract

Alzheimer disease is a complex neurodegenerative disorder. It is the common form of dementia in elderly people. The etiology of this disease is multifactorial, pathologically it is accompanied with accumulation of amyloid beta and neurofibrillary tangles. Accumulation of amyloid beta and mitochondrial dysfunction leads to oxidative stress. In this study, neuroprotective effect of Artemisiaamygdalina against H_2O_2-induced death was studied in differentiated N2a and SH-SY5Ycells. Cells were treated with H_2O_2 to induce toxicity which was attenuated by Artemisia amygdalina. The nuclear factor erythroid 2-related factor 2 (Nrf2) is an emerging regulator of cellular resistance to oxidants. It controls the basal and induced expression of antioxidant response element-dependent genes. Further, we demonstrated that Artemisia amygdalina protects neurons through upregulation of Nrf2 pathway. Moreover, reactive oxygen species and mitochondrial membrane potential loss formed by H_2O_2 was attenuated by Artemisia amygdalina. Thus, Artemisia amygdalina may have the possibility to be a therapeutic agent for Alzheimer disease.

Keywords: Antioxidant; Artemisia amygdalina; Neuroprotection; Nrf2; Oxidative stress.

Review > Appl Biochem Biotechnol. 2019 Jan;187(1):47-74. doi: 10.1007/s12010-018-2797-0. Epub 2018 Jun 8.

Recent Trends in the Fabrication of Starch Nanofibers: Electrospinning and Non-electrospinning Routes and Their Applications in Biotechnology

Roqia Ashraf [1], Hasham S Sofi [1], Aijaz Malik [2], Mushtaq A Beigh [1], Rabia Hamid [1] [3], Faheem A Sheikh [4]

Affiliations + expand

PMID: 29882194 DOI: 10.1007/s12010-018-2797-0

Full text links   Cite

Abstract

Electrospinning a versatile and the most preferred technique for the fabrication of nanofibers has revolutionized by opening unlimited avenues in biomedical fields. Presently, the simultaneous functionalization and/or post-modification of as-spun nanofibers with biomolecules has been explored, to serve the distinct goals in the aforementioned field. Starch is one of the most abundant biopolymers on the earth. Besides, being biocompatible and biodegradable in nature, it has unprecedented properties of gelatinization and retrogradation. Therefore, starch has been used in numerous ways for wide range of applications. Keeping these properties in consideration, the present article summarizes the recent expansion in the fabrication of the pristine/modified starch-based composite scaffolds by electrospinning along with their possible applications. Apart from electrospinning technique, this review will also provide the comprehensive information on various other techniques employed in the fabrication of the starch-based nanofibers. Furthermore, we conclude with the challenges to be overcome in the fabrication of nanofibers by the electrospinning technique and future prospects of starch-based fabricated

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Recent Trends in the Fabrication of Starch Nanofibers: Electrospinning and Non-electrospinning Routes and Their Applications in Biotechnology

Roqia Ashraf[1] · Hasham S. Sofi[1] · Aijaz Malik[2] · Mushtaq A. Beigh[1] · Rabia Hamid[1,3] · Faheem A. Sheikh[1]

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Abstract Electrospinning a versatile and the most preferred technique for the fabrication of nanofibers has revolutionized by opening unlimited avenues in biomedical fields. Presently, the simultaneous functionalization and/or post-modification of as-spun nanofibers with biomolecules has been explored, to serve the distinct goals in the aforementioned field. Starch is one of the most abundant biopolymers on the earth. Besides, being biocompatible and biodegradable in nature, it has unprecedented properties of gelatinization and retrogradation. Therefore, starch has been used in numerous ways for wide range of applications. Keeping these properties in consideration, the present article summarizes the recent expansion in the fabrication of the pristine/modified starch-based composite scaffolds by electrospinning along with their possible applications. Apart from electrospinning technique, this review will also provide the comprehensive information on various other techniques employed in the fabrication of the starch-based nanofibers. Furthermore, we conclude with the challenges to be overcome in the fabrication of nanofibers by the electrospinning technique and future prospects of starch-based fabricated scaffolds for exploration of its applications.

Keywords Electrospinning · Starch nanofibers · Tissue-engineering · Wound dressing · Drug delivery

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GSK3β phosphorylates Six1 transcription factor and regulates its APC/C^{Cdh1} mediated proteosomal degradation

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ARTICLE INFO

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ABSTRACT

Sine oculis homeobox homolog 1 (Six1) is a developmentally important transcription factor that regulates cellular proliferation, apoptosis, and dissemination during embryogenesis. Six1 overexpression as reported in multiple cancers modulates expression of a repertoire of its target genes causing an increase in proliferation, metastasis and survival of cancer cells. Six1 exists as a cell cycle regulated nuclear phosphoprotein and its cellular turnover is regulated by APC/C (Anaphase promoting complex / Cyclosome) complex mediated proteolysis. However, the kinases that regulate Six1 proteolysis have not been identified and the mechanistic details that cause its overproduction in various cancers are lacking. Here, we report that Six1 is a physiological GSK3β substrate. GSK3β interacts with Six1 and phosphorylates it at Ser^{221} within the conserved consensus sequence in its carboxy terminus. Using pharmacological inhibition, siRNA mediated knockdown and protein overexpression of GSK3β; we show that GSK3β regulates Six1 protein stability. Pulse chase analysis of Six1 revealed that GSK3β regulates its ubiquitin proteolysis such that Six1 phosphomimicking mutant ($Six1^{S221E}$) for Ser^{221} site had dramatically increased half-life than its phosphodeficient ($Six1^{S221A}$) and wild type variants. Furthermore, we demonstrate that GSK3β rescues Six1 from APC dependent proteolysis by regulating its binding with APC/C co-activator protein Cdh1. Importantly, strong positive correlation exists between GSK3β and Six1 protein levels throughout the cell cycle and in multiple cancers indicating that GSK3β activation may in part contribute to Six1 overproduction in a subset of human cancers.

1. Introduction

Six1 is a developmentally controlled homeoprotein that regulates expression of a large subset of genes involved in cellular proliferation, differentiation, and migration [1–3]. Overproduction of Six1 protein has been reported in multiple cancers like breast, colorectal, gastric, ovarian etc. and correlates with disease prognosis [4–9]. Six1 is known to regulate the expression of multiple genes, such as c-myc, Ezrin, Cyclin A1, MMP-2, VEGF, ZEB1, HK2 and GAPDH which are involved in proliferation, survival, migration, and invasion of cancer cells [3,10–13]. Specificity of Six1 interactions with promoter DNA sequences are mediated through its homeodomain (HD) or Six type domain (SD) in association with multiple other co-factors like Eya2 (Eyes absent 2), Microspherule –1 (Mcrs1) and Dachshund (DACH) family proteins [14–17].

Six1 expression, which is one of the key determinants of cellular phenotype in several pathophysiological states has been reported to be regulated by gene amplification and APC/C^{Cdh1} proteolysis [6,18]. Six1 is a phosphoprotein and its binding to promoter regions is regulated by phosphorylations mostly mediated by Protein kinase CK2 (CK2) [19]. However, a detailed mechanistic understanding of how Six1 levels are regulated post-translationally is not properly understood.

GSK3 is a constitutively active ser/thr kinase in resting cells regulating cellular expression and/or localization of a plethora of substrates [20]. GSK3 is inhibited by phosphorylation at Ser9/21 mediated by other growth factor signalling inputs via molecules like AKT/PKB [21].

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REVIEW ARTICLE

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TGF-β signaling: A recap of SMAD-independent and SMAD-dependent pathways

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Abstract

Transforming growth factor-β (TGF-β) is a proinflammatory cytokine known to control a diverse array of pathological and physiological conditions during normal development and tumorigenesis. TGF-β-mediated physiological effects are heterogeneous and vary among different types of cells and environmental conditions. TGF-β serves as an antiproliferative agent and inhibits tumor development during primary stages of tumor progression; however, during the later stages, it encourages tumor development and mediates metastatic progression and chemoresistance. The fundamental elements of TGF-β signaling have been divulged more than a decade ago; however, the process by which the signals are relayed from cell surface to nucleus is very complex with additional layers added in tumor cell niches. Although the intricate understanding of TGF-β-mediated signaling pathways and their regulation are still evolving, we tried to make an attempt to summarize the TGF-β-mediated SMAD-dependent andSMAD-independent pathways. This manuscript emphasizes the functions of TGF-β as a metastatic promoter and tumor suppressor during the later and initial phases of tumor progression respectively.

KEYWORDS
angiogenesis, chemoresistance, metastasis

1 | TGF-β—A VERSATILE CYTOKINE

Transforming growth factor-β (TGF-β) superfamily includes a variety of conserved growth factors, each controlling a wide network of cellular tasks encompassing cellular differentiation, proliferation, cell death, cell adhesion, motility, lineage determination, adult tissue homeostasis, and embryogenesis. TGF-β and its structurally related polypeptide factors are expressed in a complex tissue-specific and temporal manner and play an important part in repair during tissue damage and organismal homeostasis in all organisms from Drosophila to humans. These polypeptide factors conjointly comprise a significant proportion of cellular signals that dictate cell fate (Hata & Chen, 2016; Massagué, 1998; Tzavlaki & Moustakas, 2020). Dysregulation of TGF-β signaling results in the development of various diseases like cancer and fibrotic diseases and also leads to various developmental defects (Rik Derynck & Budi, 2019). TGF-β signaling emerged in the early metazoan evolution. A few elements of the pathway are also present in the existent non-metazoans, pointing to the advent of this pathway as a major upheaval in switching to multicellularity by the early metazoans. Although the SMAD homologs were also detected in the choanoflagellates, there is no evidence of TGF-β receptors and ligands outside the metazoans (Pang et al., 2011). As many as 30 members of the TGF-β superfamily are reported in humans and many orthologs are described in xenopus, mouse, and other vertebrates (Massagué et al., 2000). Seven members of the family are reported in *Drosophila melanogaster* (Raftery & Sutherland, 1999) and seven in *C. elegans* (Padgett et al., 1998). The members of the TGF-β superfamily are generally divided into two categories that include the bone morphogenetic protein (BMP)/growth and differentiation factor (GDF) and TGF-β/activin/nodal

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Review

SIX1 transcription factor: A review of cellular functions and regulatory dynamics

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Abstract

Sine Oculis Homeobox 1 (SIX1) is a member of homeobox transcription factor family having pivotal roles in organismal development and differentiation. This protein functionally acts to regulate the expression of different proteins that are involved in organ development during embryogenesis and in disorders like cancer. Aberrant expression of this homeoprotein has therefore been reported in multiple pathological complexities like hearing impairment and renal anomalies during development and tumorigenesis in adult life. Most of the cellular effects mediated by it are mostly due to its role as a transcription factor. This review presents a concise narrative of its structure, interaction partners and cellular functions vis a vis its role in cancer. We thoroughly discuss the reported molecular mechanisms that govern its function in cellular milieu. Its post-translational regulation by phosphorylation and ubiquitination are also discussed with an emphasis on yet to be explored mechanistic insights regulating its molecular dynamics to fully comprehend its role in development and disease.

RESEARCH PAPERS: GASTROINTESTINAL CANCER

Impact of catechol-*O*-methyltransferase gene variants on methylation status of *P16* and *MGMT* genes and their downregulation in colorectal cancer

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BUY

Metrics

Abstract

Globally, colorectal cancer (CRC) is the third most commonly diagnosed cancer in males and the second most commonly diagnosed cancer in females, with 1.4 million new cases and almost 694 000 deaths estimated to have occurred in 2012. The development and progression of CRC is dictated by a series of alterations in diverse genes mostly proto-oncogenes and tumor suppressor genes. In this dreadful disease disturbances different from mutations called as epigenetic regulations are also taken into consideration and are thoroughly investigated. The present study was designed to analyze the promoter hypermethylation of CpG (cytosine, followed by guanine nucleotide) islands of cyclin-dependent kinase inhibitor 2A (*P16*) and O^6-methylguanine-DNA methyltransferase (*MGMT*) genes and its subsequent effect on the protein expression in CRC. The impact of the common functional polymorphism of the catechol-*O*-methyltransferase (*COMT*) gene, Val158Met, on promoter hypermethylation of *P16* and *MGMT* genes in CRC was also investigated. The study included 200 CRC cases and equal numbers of normal samples. DNA was extracted using the kit method and methylation specific-PCR was performed for analysis of the promoter hypermethylation status. Total protein was isolated form all CRC cases and western blotting was performed for P16 and MGMT proteins. The COMT Val158Met polymorphism was analyzed by a PCR-restriction fragment length polymorphism assay. Epigenetic analysis showed that unlike other high-risk regions, the Kashmiri population has a different promoter hypermethylation profile of both *P16* and *MGMT* genes, with frequent and significant promoter hypermethylation of both in CRC. The frequency of promoter hypermethylation of both genes was significantly higher in males and was insignificantly found to be higher in stage III/IV. The degree of *P16* and *MGMT* promoter hypermethylation increased significantly with increasing severity of the lesion. We also found a significant correlation between *P16* and *MGMT* promoter hypermethylation and loss of protein expression in CRC. A significant association was found between *COMT* polymorphism (homozygous variant) and *P16* methylation status. Similar results were also found for *MGMT* hypermethylated cases.

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Comparative study on silver nanoparticles adsorption by ultrasonication and hydrothermal approaches on β-cyclodextrin incorporated polyurethane micro-nanofibers as multifunctional tissue engineering candidate

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ARTICLE INFO

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Fiber
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ABSTRACT

For an efficient tissue-engineered implant, it is mandatory to have appropriate fluid absorption and antibacterial properties. In this regard, polyurethane micro-nanofibers were modified by incorporating β-cyclodextrin by electrospinning and then adsorbed using silver (Ag) nanoparticles (NPs). We selected the adsorption by ultrasonication and hydrothermal methods and compared results for hydrophilicity, biodegradation, biocompatibility, and antibacterial activity. Scanning electron microscopy confirmed fiber diameter in mats with hydrothermally adsorbed Ag NPs was 8.0 ± 2.2 μm, and that of ultrasonically adsorbed Ag NPs was 4.0 ± 1.7 μm. The hydrophilicity results showed that incorporation of β-cyclodextrin in mats led to the decrease in water angle, and the Ag NPs adsorbed mats measured 53.50 ± 0.1° and 55.18 ± 0.15° at 1 min. The Ag NPs release by UV–visible spectroscopy indicated higher release in the case of ultrasonically adsorbed Ag NPs. Ultrasonically adsorbed Ag NPs showed higher antibacterial activity than hydrothermally against *Staphylococcus aureus* and *Escherichia coli* with 15 ± 2 mm and 12 ± 1 mm clear zones. The mouse fibroblasts showed a viability of >100 % in all mats, which determined that the fibers were biocompatible. The highest viability was seen in ultrasonically adsorbed Ag NP mats (262.76 ± 11.24 %). The cell attachment studies showed well-spread cells, concluding with excellent biocompatibility. Overall, results indicate ultrasonic adsorption is a straightforward and better strategy than hydrothermal treatment.

1. Introduction

The complex structure of tissues in the human body may encounter degenerative diseases, trauma, and/or damage in their lifetime. Therefore, searching for novel strategies to renew and regenerate the affected tissue is paramount [1]. These strategies include using various biomaterials that can be used for the repair and/or replacement of damaged tissues following their optimization [2]. In this regard, there have been extensive studies using natural and synthetic polymer-based electrospun nanofibers as scaffolds for tissue growth and regeneration [3]. Polyurethane (PU) is a versatile class of biomaterials that has achieved enormous attention as a synthetic polymer for its role in tissue engineering [4]. It possesses biocompatibility, biodegradability, and tailorable chemical, mechanical and thermal properties [5,6]. It also inherits elasticity and non-immunogenic properties [7], because of which PU is extensively employed in biological engineering, such as in the fabrication of sensors [8], wound dressing [9], drug carriers [10], protein incorporation in cells [11] and above all as scaffolds for varied soft [12] and hard tissue engineering applications [13]. However, the inherent hydrophobic nature of PU and its fibers destabilises its biological

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RESEARCH ARTICLE

A facile route to synthesize β-Ga_2O_3 nanoparticles from γ-polymorph through a rapid microwave route and their optical properties

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Abstract

Due to the wide bandgap, monoclinic structure and thermodynamic stability, β-polymorph form of Ga_2O_3 nanomaterials is well-received for various applications. However, as the γ-Ga_2O_3 is difficult to synthesize, less attention has been paid towards it and its conversion to β-polymorph. This paper reports the single-step synthesis of γ-Ga_2O_3 using a microwave-assisted procedure. In this regard, γ-Ga_2O_3 powders are synthesized in minutes using benzyl alcohol as the solvent using gallium acetylacetone as the precursor. The XRD of the as-prepared powders indicates the formation of the γ-Ga_2O_3 phase, the very broad peaks indicative of the small crystallite size as confirmed by TEM. The γ-Ga_2O_3 powders were annealed at different temperatures and the complete phase conversion of γ-Ga_2O_3 phase to β-Ga_2O_3 phase happens at 700 °C. The TEM analysis shows the crystallite size to be ≈10 nm for the annealed β-Ga_2O_3 phase. The as-prepared nanopowders show very weak luminescence under excitation and in contrast, a blue-green emission is observed in case of annealed powders. This confirms the presented strategy as having the potential to use β-Ga_2O_3 nanopowders for different optoelectronic applications.

KEYWORDS
FTIR, Ga_2O_3, luminescence, microwave-synthesis, nanoparticles

1 | INTRODUCTION

New synthesis techniques that enable scientists to perform more experiments within a given time would be very beneficial to scientific community as well as the R&D enterprise. Microwave-assisted solution-based chemistry, which makes fast synthesis possible, is such a technique.[1,2] Microwave-assisted synthesis (MAS) of inorganic materials is considered a nascent technology which dramatically reduces reaction times due to the solvent superheating effect, improving reaction yields, avoiding byproducts and simplifying/shortening reaction procedures for combinatorial chemistry. Furthermore, MAS uses a safe heating source that can turned "on" and "off" instantaneously and can be applied in solvent-free environment. This often offers better product quality, sustainability and chemical yield, which is the advantageous compared to traditional heating sources.[3] Therefore, the MAS technique is expected to play an significant role in the environmentally friendly "synthetic nanotechnology" of the future.[1] Microwave-enhanced chemistry is based on the efficient heating of molecules by two main mechanisms: dipole rotation and ionic conduction which has been widely discussed by several authors.[1,3] The microwave technique greatly contributes to all areas of synthetic chemistry, particularly in the fabrication of nanostructures. The field of

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Silk fibroin-copper nanoparticles conglomerated polyurethane fibers incorporating calcium carbonate for enhanced fluid retention, antibacterial efficacy and promotion of cell growth

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ABSTRACT

This work blended calcite crystals with polyurethane solution and fabricated into micro/nanofibers by electrospinning. Subsequently, these fibers were hydrothermally coated using silk fibroin and deposited with copper (Cu) nanoparticles (NPs). The morphology of fibers was smooth, and the diameter increased upon incorporation of $CaCO_3$ from 1.56 ± 1.07 μm to 3.35 ± 0.8 μm. Adding SF and Cu increased the fiber diameter, and partial or complete masking of fibrous morphology occurred with higher concentrations. The contact angle declined from 105.3 ± 0.1° to 12.1 ± 0.1° in the scaffold with SF and Cu NPs, indicating hydrophilicity. The hydrothermally modified scaffolds showed multi-step decomposition temperature with improved thermal stability compared to pristine samples. The tensile strength of PU micro/nanofibers increased from 158.5 ± 0.5 MPa to 200.06 ± 0.2 MPa, and the enzymatic degradation of 46.6 ± 0.4% after 120 days was seen upon adding SF. The antibacterial activity of fibers against Escherichia coli (20.7 ± 0.16 mm) and Staphylococcus aureus (20.5 ± 0.4 mm) demonstrated significant antibacterial activity. The growth curve studies and biofilm inhibition tests from OD measurements showed self-inducing antibacterial activity from the hydrothermal deposition of Cu NPs. The 3T3 L1 and NIH 3T3 cells attached firmly and proliferated well on scaffolds with SF and Cu NPs. The measured cell viability was >300% and ≈200% in all composite scaffolds.

1. Introduction

Nanofibers have emerged as a revolutionary materials in bone tissue engineering, offering unique advantages for regenerating and repairing damaged or diseased bone [1]. These ultrafine fibers, typically on the nanoscale, mimic the natural extracellular matrix structure of bone, providing a three-dimensional scaffold that promotes cell adhesion, proliferation, and differentiation [2]. The high surface area and porous nature of nanofibers facilitate effective nutrient and oxygen exchange, fostering a conducive microenvironment for bone-forming cells [1]. Moreover, the tunable mechanical properties of nanofibers allow for customization to match the specific requirements of different bone types and applications [2]. Functionalizing nanofibers with bioactive molecules or growth factors further enhances their ability to stimulate bone cell activity [3]. As a result, nanofiber-based scaffolds hold immense potential for promoting accelerated and efficient bone tissue regeneration, offering a promising avenue for addressing critical challenges in orthopedics and bone-related disorders. Electrospun polyurethane (PU) micro and nanofibers have gained considerable attention due to their high surface area-to-volume ratio, porous structure, and tenable mechanical properties similar to natural extracellular matrix (ECM) [4]. With the advent of technology, PU has been incorporated with various filler molecules according to the desired application. For wound healing, it has been integrated with natural polymers (e.g., gelatin [5] and cellulose [6]), with oils (e.g., murivenna [7] and lavender [8]), with antibiotic agents (e.g., ampicillin [9], silver [10]), with hormones (e.g., estradiol [11] and estrogen [12]), with ECM components (e.g., hyaluronic acid [13] and collagen [14]) and plant extracts (e.g., *Malva*

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REVIEW ARTICLE

Magnesium-reinforced Electrospun Synthetic-polymer Nanofibers Designed for Promoting Tissue Growth

Muheeb Rafiq[1] · Anjum Hamid Rather[1] · Rumysa Saleem Khan[1] · Taha Umair Wani[1,2,3] · Haseeb A. Khan[4] · Abdullah S. Alhomida[4] · Faheem A. Sheikh[1]

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Abstract

The creation of 3D nanofibers offering desirable functions for bone regeneration is developed due to the latest improvisations to the electrospinning technique. Synthetic polymers are among the best choices for medical usage due to their lower costs, high tensile properties, and ease of spinnability compared to natural polymers. In this communication, we report a series of interventions to polymers modified with Mg-based fillers for ideal tissue engineering applications. The literature survey indicated that these filler materials (e.g., nano-sized particles) enhanced biocompatibility, antibacterial activity, tensile strength, and anti-corrosive properties. This review discusses electrospinning parameters, properties, and applications of the poly(ε-caprolactone), poly(lactic acid), poly(3-hydroxybutyric acid-co-3-hydroxy valeric acid), polyurethane, and poly(vinyl pyrrolidone) nanofibers when modified with Mg-based fillers. This report encourages researchers to use synthetic polymers with Mg as fillers and validate them for tissue engineering applications.

Keywords Bone regeneration · Magnesium · Nanofibers · Tissue engineering

1 Introduction

Electrospun nanofibers have been used as a base material due to their advanced surface-to-volume ratio and resemblance with the native extracellular matrix present in multicellular organisms. However, using pristine nanofibers without modifications offers few desired outcomes and, therefore, does not qualify as a suitable candidate for replacing extracellular matrix [1]. For instance, polyurethane (PU) nanofibers are hydrophobic and can restrict cell attachment [2]. On the other hand, nanofibers made from poly(vinyl alcohol) are water soluble and can be immediately disintegrated in contact with biofluids [3]. Modifying them gives exceptional mechanical and biological attributes, making them desirable for biomedical applications, including drug delivery [4], wound dressing [5], and medical implants [6]. These modifications are achieved by pre- or post-treatment approaches [7], such as blending with fillers [8], hydrothermal treatment [9], plasma treatment [10], dip-coating [11], etc. [12]. Therefore, it is highly imperative to modify these nanofibers using the latest strategies that can help successfully exploit their potential.

The most preferred technique available to scientists for fabricationing nanofibers is electrospinning [13]. This technique involves the electrification of the liquid droplet, resulting in the creation of a jet. Later on, the electrostatic attraction between the jet and the collector results in the formation of nanofibers, which eventually get deposited in the form of mats [14–16]. During the electrospinning process, we can quickly achieve the goal of changing the pristine polymers, giving them different characteristics. One such approach involves the addition of different fillers in the spinning solution, such as gold [17], silver [18], copper

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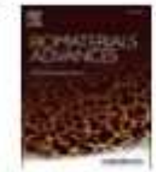

Optimizing the fabrication of electrospun nanofibers of prochlorperazine for enhanced dissolution and permeation properties

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ARTICLE INFO

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Rapid disintegration

ABSTRACT

Despite being an approved antiemetic for more than five decades, the clinical usefulness of prochlorperazine is limited by its low solubility and inconsistent absorption in the gastrointestinal tract, which presents challenges for nanotherapeutic interventions. Here, we report the preparation of a highly soluble and permeable nanofiber formulation of prochlorperazine using the Quality-by-Design approach. The final nanofiber formulation with drug entrapment of 88.02 ± 1.14 % was obtained at 20.0 kV, with a flow rate of 0.5 ml/h and tip-to-collector distance of 19.9 cm. Physio-mechanical properties, such as thickness (0.42 ± 0.02 mm), pH resistance (7.04 ± 0.08), folding endurance (54 ± 5), and tensile strength (0.244 ± 0.02 N.mm^{-2}), were appropriate for packaging and application to oromucosal surfaces. The content uniformity (93.48–106.63 %) and weight variation (<1.8 mg) of the optimal nanofiber formulation were within the permissible limits prescribed for orodispersible films. Microscopical investigations confirm a randomly deposited and dense network of woven nanofibers with an average diameter of 363 ± 5.66 nm. The drug particles were embedded homogeneously on the fiber in the nanoform (4.27 ± 1.34 nm). The spectral analysis using TEM-EDS shows diffraction peaks of sulfur and chlorine, the elemental constituents of prochlorperazine. The drug was amorphized in the nanofiber formulation, as led by the decline of the crystallinity index from 87.25 % to 7.93 % due to electrostatic destabilization and flash evaporation of the solvent. The enthalpy of fusion values of the drug in the nanofiber mat decreased significantly to 23.6 J/g compared to its pristine form, which exhibits a value of 260.7 J/g. The nanofibers were biocompatible with oral mucosal cells, and there were no signs of mucosal irritation compared to 1 % sodium lauryl sulfate. The fiber mats rapidly disintegrated within <1 s and released ≈91.49 ± 2.1 % of the drug within 2 min, almost 2-fold compared to the commercial Stemetil MD® tablets. Similarly, the cumulative amount of the drug permeated across the unit area of the oromucosal membrane was remarkably high (31.28 ± 1.30 μg) compared to 10.17 ± 1.11 μg and 13.10 ± 1.79 μg from the cast film and drug suspension. Our results revealed these nanofiber formulations have the potential to be fast-dissolving oromucosal delivery systems, which can result in enhanced bioavailability with an early onset of action due to rapid disintegration, dissolution, and permeation.

1. Introduction

Orally fast disintegrating delivery systems have been in the pharmaceutical market for decades. The need for rapid delivery of drugs is gaining prominence in industries. It has since evolved from formulating oral disintegrating (OD) tablets/capsules to other delivery

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ORIGINAL ARTICLE

Characterization of Gold-Enhanced Titania: Boosting Cell Proliferation and Combating Bacterial Infestation

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Abstract

BACKGROUND: In this study an approach was made to efficaciously synthesize gold enhanced titania nanorods by electrospinning. This study aims to address effects of gold enhanced titania nanorods on muscle precursor cells. Additionally, implant related microbial infections are prime cause of various disastrous diseases. So, there is predictable demand for synthesis of novel materials with multifunctional adaptability.

METHODS: Herein, gold nanoparticles were attached on titania nanorods and described using many sophisticated procedures such as XRD, SEM, EDX and TEM. Antimicrobial studies were probed against Gram-negative *Escherichia coli.* C2C12 cell lines were exposed to various doses of as-prepared gold enhanced titania nanorods in order to test *in vitro* cytotoxicity and proliferation. Cell sustainability was assessed through Cell Counting Kit–8 assay at regular intervals. A phase-contrast microscope was used to examine morphology of exposed C2C12 cells and confocal laser scanning microscope was used to quantify cell viability.

RESULTS: The findings indicate that titania nanorods enhanced with gold exhibit superior antimicrobial efficacy compared to pure titania. Furthermore, newly synthesized gold-enhanced titania nanorods illustrate that cell viability follows a time and concentration dependent pattern.

CONCLUSION: Consequently, our study provides optimistic findings indicating that titania nanorods adorned with gold hold significant potential as foundational resource for developing forthcoming antimicrobial materials, suitable for applications both in medical and biomedical fields. This work also demonstrates that in addition to being extremely biocompatible, titania nanorods with gold embellishments may be used in a range of tissue engineering applications in very near future.

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ORIGINAL PAPER

Hydrothermal Modification of Polyurethane Fibers Using Hyaluronic Acid and Silver Nanoparticles for Wound Healing

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Abstract
Different wounds take a while to heal, and the process is frequently accompanied by bacterial infection and scar formation. This study aimed to fabricate polyurethane (PU) fibers through electrospinning, utilizing a mixture of THF and DMF solvents in a 90:10 ratio. Subsequently, these fibers were coated with different concentrations of hyaluronic acid (HA) and silver (Ag) nanoparticles (NPs) using the hydrothermal treatment to create biocompatible and antibacterial scaffolds applicable to wound management. Pristine samples served as a basis for comparison. Following high-temperature usage during the hydrothermal coating, the Field emission scanning electron microscopy (FE-SEM) results showed defect-free morphology. However, the fibers' diameter significantly increased by layer of HA. In particular, the diameter of the PU fibers was 1.87 ± 1.1 µm, whereas the fibers with the maximum amount of HA (0.5%) had an enlargement of 4.43 ± 1.4 µm in fiber diameter. The Fourier transform infrared (FTIR) spectroscopy demonstrated the presence of distinctive functional groups, supporting the hypothesis that HA and Ag NPs were efficaciously coated on PU fibers. Moreover, HA-coated fibers improved hydrophilicity, mechanical strength, thermal stability, degradability, and biomineralization. Notably, the Ag-coated scaffolds exhibited antibacterial activity against *E. coli* and *S. aureus*. The MTT assay, DAPI staining, and FE-SEM results after culturing HEK 293T cells have demonstrated the biocompatibility of the nanocomposite fibers. In other words, the developed HA and Ag NPs coated PU fibers by hydrothermal technique would be a futuristic method for promoting tissue healing and imparting antibacterial ability in curing skin wounds.

Keywords Hyaluronic acid · Electrospinning · Hydrothermal treatment · Antibacterial · Cell viability

Introduction

Damage to underlying tissue or organ is referred to as a wound, and treating such injury presents a challenging task. Polymer-based wound dressing is a novel approach to treating this complex problem [1]. Moreover, the appropriate moisture is essential for healing because it encourages the migration of new skin cells from the edges, which speeds up wound closure [2]. In this regard, numerous techniques have been put forward, helping to fabricate efficient wound-healing scaffolds [3]. However, electrospinning stands out for its affordability, suited porosity, mechanical integrity,

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Polyurethane and cellulose acetate micro-nanofibers containing rosemary essential oil, and decorated with silver nanoparticles for wound healing application

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Tissue engineering
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ABSTRACT

In this study, polyurethane (PU) and cellulose acetate (CA) electrospun fibers encapsulating rosemary essential oil (REO) and adsorbed silver (Ag) nanoparticles (NPs) were fabricated. The biologically inspired materials were analyzed for physicochemical characteristics using scanning electron microscopy, X-ray diffractometer, Fourier transform infrared, thermal gravimetric analysis, X-ray photoelectron spectroscopy, water contact angle, and water uptake studies. Results confirmed the presence of CA and Ag NPs on the PU micro-nanofibers increased the hydrophilicity from 107.1 ± 0.36° to 26.35 ± 1.06°. The water absorption potential increased from 0.07 ± 0.04 for pristine PU fibers to 12.43 ± 0.49 % for fibers with 7 wt% of CA, REO, and Ag NPs. The diffractometer confirmed the 2θ of 38.01°, 44.13°, and 64.33°, corresponding to the diffraction planes of Ag on the fibers. The X-ray photoelectron spectroscopy confirmed microfibers interfacial chemical interaction and surface changes due to CA, REO, and Ag presence. The inhibition tests on *Staphylococcus aureus* and *Escherichia coli* indicated that composites are antibacterial in activity. Moreover, synergistic interactions of REO and Ag NPs resulted in superior antibacterial activity. The cell viability and attachment assay showed improved hydrophilicity of the fibers, which resulted in better attachment of cells to the micro-nanofibers, similar to the natural extracellular matrix in the human body.

1. Introduction

Polyurethane (PU) is a synthetic polymer extensively used to fabricate novel wound dressing materials. Better oxygen permeability, barrier properties, biodegradability, and biocompatibility make it an ideal candidate for tissue engineering applications [1]. Furthermore, because PU has good spinnability, it can easily be fabricated into micro-and nanofibers by the electrospinning technique [2]. This technique affords a web-like structure composed of micro-nanofibers that resemble the native extracellular matrix (ECM) arrangement in the human body [3]. However, being an excellent wound dressing material, owing to its resemblance to ECM, the scaffolds fabricated from PU need additional modifications for enhanced clinical use [4]. This is because dressing materials made from PU fibers are highly hydrophobic, which is not favorable for cell attachment and growth. The hydrophobic nature of this polymer results in poor adhesion to the injury site, leading to insufficient adsorption of exudate and the inability to release antibacterial and/or other therapeutic agents that might be loaded within the fibers [5].

Several strategies have come in place to change the hydrophobic

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Review

Nanozymes: A comprehensive review on emerging applications in cancer diagnosis and therapeutics

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ABSTRACT

Nanozymes, a new class of nanomaterials-based artificial enzymes, have gained huge attraction due to their high operational stability, working efficiency in extreme conditions, and resistance towards protease digestion. Nowadays, they are effectively substituted for natural enzymes for catalysis by closely resembling the active sites found in natural enzymes. Nanozymes can compensate for natural enzymes' drawbacks, such as high cost, poor stability, low yield, and storage challenges. Due to their transforming nature, nanozymes are of utmost importance in the detection and treatment of cancer. They enable precise cancer detection, tailored drug delivery, and catalytic therapy. Through enhanced diagnosis, personalized therapies, and reduced side effects, their adaptability and biocompatibility can transform the management of cancer. The review focuses on metal and metal oxide-based nanozymes, highlighting their catalytic processes, and their applications in the prevention and treatment of cancer. It emphasizes their potential to alter diagnosis and therapy, particularly when it comes to controlling reactive oxygen species (ROS). The article reveals the game-changing importance of nanozymes in the future of cancer care and describes future research objectives, making it a useful resource for researchers, and scientists. Lastly, outlooks for future perspective areas in this rapidly emerging field have been provided in detail.

1. Introduction

Nanozymes are natural enzyme mimicking nanomaterials that are gaining preference over protein-based enzyme in the realm of novel therapeutic and diagnostic agents [1]. Nanozymes can be described as nano-sized enzymes in the nano-range i.e., 1–100 nm. They conquer the limitations of natural enzymes, like high cost, production complexity [2], instability [3], and inherent environmental sensitivity which has limited the use of naturally occurring enzymes [4]. Natural enzymes' sensitivity to environmental factors can restrict their utility in specific cancer-related applications. Conversely, nanozymes are biocompatible, versatile, and suitable for various aspects of cancer therapy, e.g., drug delivery [5]. Nanozymes possess identical enzymatic characteristics and catalytic efficiency as natural enzymes, they can catalyse enzyme-substrate reactions within physiological criteria [6,7]. Nanozymes provide high stability [8,9], minimal cost [9,10], reliability [11,12], and catalytic activity [8,13] under a wider range of circumstances, including changes in temperature and pH [14]. The extraordinary adaptability of nanozymes enables interaction with a wide range of substrates and molecules that are important to cancer, including biomarkers and therapeutic drugs. These nano-sized enzymes can be designed for controlled and prolonged release of drugs due to their increased permeability and retention impact in disease tissues [15].

The characteristics of nanozymes can be easily tuned by their size, shape, and surface to make them suitable for multifunctional nano-systems and allow for improved catalytic performance in cancer-specific sites [16]. Nanozymes may be easily made in laboratories, unlike real enzymes, which require complex extraction from organisms and are available in limited quantities. The mass production of nanozymes can also be possible at low cost with consistent quality, which increases their

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Hydrothermal Modification of As-Spun Polyurethane Micro-Nanofibers Using Silk Fibroin and Biologically Reduced Silver Nanoparticles for Efficient Hydrophilicity and Antibacterial Properties

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The hydrophobicity of polyurethane fibers is undesired for tissue engineering. In this work, fibers are fabricated by electrospinning and coated with silk fibroin (SF) for biocompatibility and biologically synthesized silver (Ag) nanoparticles (NPs) for antibacterial activity. The scanning electron microscopy revealed the undistorted morphology and the presence of NPs on fibers. The Fourier transform infrared and thermogravimetric analysis show the successful incorporation of SF and Ag NPs. The water contact angle drops from 101.26±0.2° in pristine to 3.1±0.3° in the hydrothermally treated fibers. The moisture regain from 1.87±0.3% to 6.7±0.4% is observed after 24 h. The mineralization shows the hydroxyapatite NPs in all composites. The large zone of inhibition is observed in the composite, with the Ag NPs equal to 11.5±0.04 mm for *Staphylococcus aureus* and 18.91±0.02 mm for *Escherichia coli*. The increased proliferation of HEK 293T cells for 6 days of culture on composite scaffolds compared to the pristine scaffolds is achieved. The cell attachment examinations show successful attachment of cells on fibers and nuclear staining analysis shows the highest proliferation in scaffolds with an intermediate concentration of Ag NPs (10%). This strategy presents a novel improvisation for as-spun PU fibers that can fabricate wound-healing biomaterials for tissue engineering.

1. Introduction

Tissue engineering involves the fabrication of scaffolds, a primary requirement for any tissue to grow artificially. Among various prerequisites of a material employed for scaffold fabrication, two important properties are its ability to remove the exudates and protection from infection. The characteristics of an ideal wound healing material to satisfy the abovementioned requirements are that it should have high porosity for the permeation of fluids and exchange of gases. Furthermore, it should have a suitable barrier property against microbial infections and should not dehydrate immediately.[1] Fabricating such scaffolds using the electrospinning technique requires a lot of consideration, and tissue engineers have partially explored this.[2] Micro-nanofibers manufactured by electrospinning have been used since the 1930s to prepare nonwoven fiber and have revitalized tissue engineering.[3,4] Researchers have developed a significant interest in this technique because the parameters, such as solution concentration, voltage, flow rate, tip-to-collector distance, viscosity, conductivity, etc., are changeable and can be easily tuned to obtain desired morphology. Furthermore, with the help of electrospinning, it is possible to precisely mimic the structure of the extracellular matrix (ECM) by selecting the suitable polymers desired to perform specific biological functions.[5] Over the years, all these modifications and improvisations to the electrospinning

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Research Article

Vertically aligned calcium phosphate nanoplates coated onto melt electrowritten 3D poly(ε-caprolactone) fibrous scaffolds for inhibiting biofilm formation

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Additive manufacturing
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Poly(ε-caprolactone) (PCL)
Surface modifications

ABSTRACT

Biofilm formation on implant surfaces often results in chronic infections, which may result in implant rejection and/or necessitate the need for implant removal or additional surgeries. Effective strategies are therefore required to prevent biofilm formation on biomaterials surfaces, especially during early post-implantation stage. This work aims to fabricate a 3D fibrous scaffold coated with vertically aligned nanoplates to mitigate bacterial attachment and inhibit biofilm formation. The high-aspect-ratio 3D highly porous (>94%) fibrous scaffolds made from medical-grade poly(ε-caprolactone) (PCL) were fabricated using the melt electrowritten (MEW) technique. The MEW fibrous scaffold was modified by directly coating a layer of calcium phosphate (CaP) via a biomimetic approach. CaP minerals showed a uniform distribution onto the PCL MEW fibrous scaffold with a nanoplate-like structure (width = 45 ± 17 nm, thickness = 8 ± 1.4 nm and 150 ± 24 nm length). The treated PCL fibrous scaffold exhibited the lowest attachment of *Staphylococcus aureus* and salivary biofilms after 24 and 48 h of culturing. The remarkable level of inhibition in bacterial attachment can be attributed to the exceptional combination of composition and surface characteristics displayed by the vertically aligned CaP nanoplates. The findings strongly support the potential of using vertically aligned CaP nanoplates as a coating on the 3D fibrous scaffold. This approach offers promising and straightforward antibacterial properties, effectively mitigating the risk of implant-associated infections without the need for antibacterial drugs.

1. Introduction

Implant failure due to microbial infection remains a significant concern. If not promptly addressed, these implant device-associated infections can rapidly escalate, resulting in failure of the implant or may necessitate additional surgeries [1–3]. Bacteria can easily adhere, colonize, and cause infection at the interface between the implant and surrounding tissues [4]. Bacteria secrete adhesins and protein-polysaccharide complexes following adhesion, thereby building a biofilm resistant to host defences/antibiotics. Biofilm formation causes undesirable complications, such as inflammatory reactions, infections and destruction of the adjacent soft and hard tissues [5], eventually leading to implant loosening and complete failure. The process of biofilm formation is highly dynamic, with its initial stages taking place during the biochemical conditioning of the substrate surface [4]. This critical conditioning process allows free-living microorganisms to colonize a surface enriched with an acquired pellicle, facilitating their attachment and subsequent biofilm development [4].

Numerous biomaterials, including organic and inorganic metals, have been used for tissue regeneration in dental/bone applications. Without a doubt, no individual implantable biomaterial can consistently facilitate the coordinated growth and development of multiple tissue

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Super disintegrating oromucosal nanofiber patch of zolmitriptan for rapid delivery and efficient brain targeting

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ARTICLE INFO

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Zolmitriptan
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Brain targeting

ABSTRACT

Oromucosal administration of zolmitriptan using electrospun nanofiber can potentially result in blood plasma concentrations analogous to intravenous kinetics and targeting the brain due to anatomical features of the delivery site. Herein, we report the optimization of zolmitriptan and polyvinylpyrrolidone nanofibers using a Quality by Design approach. Fourier transform infrared spectroscopy, and Thermogravimetric analysis ruled out any physical and/or chemical interaction between the drug and excipient. Diffraction studies revealed a sharp decrease in the crystalline index of pure zolmitriptan from 85.75% to 8.35%. Likely, calorimetry studies show a sharp decline in the enthalpy of fusion from 126.4 J/g before electrospinning to 67.24 J/g post electrospinning, demonstrating amorphization of the drug. The disintegration of nanofiber occurs within less than a second, and about 82% of the medicament was released in 60 s in an in vitro test, compared to 67% from the Zomig Rapimelt® tablet. Rapid drug flux of 22.07 and 22.62 μg/cm^2/h occurred when nanofiber patches were applied to buccal and soft palate mucosa in an ex vivo permeability test. Biocompatibility studies established that the nanofiber patches were neither toxic nor irritating to the oral epithelium. Groups of rabbits received the zolmitriptan solution intravenously and orally, or optimized nanofibers were applied to the buccal and soft palate mucosa. Pharmacokinetic analysis in blood plasma indicated similar kinetics of oromucosal patches and intravenous administration. More importantly, concentrations achieved in the hindbrain after administration of the patch over the soft palatal mucosa produce significantly higher concentrations than buccal or IV administration (>2-folds). The drug targeting these brain regions likely resulted from rapid dissolution, enhanced permeation, amorphization, and specialized drug transport via a trigeminal nose base-pons-medullary axis.

1. Introduction

Drug candidates with poor water solubility and limited permeability rapidly increase, representing a significant challenge for the pharmaceutical industry [1]. These drugs represent around 85% of newly developed molecules, and about 50% are marketed. The formulation development of such active pharmaceutical ingredients is challenging when these drugs are intended for a specific population, such as geriatric, pediatric, or unconscious patients, especially when parenteral preparations are unavailable [2]. Furthermore, the pharmaceutical problem looks more attractive when these drugs demand rapid onset of action. Injectables are the best solution to counter such associated pharmaceutical issues. However, it is impossible to formulate every drug into a parenteral formulation because of the physio-chemical properties of the drug, pain associated with administration, and relatively higher cost than other formulations [3].

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Review Article

Grain refinement mechanism and its effect on mechanical properties and biodegradation behaviors of Zn alloys — A review

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ABSTRACT

Along the way, investigations over the past few years have focused on developing new Zn-based alloys as future materials for medical implants due to the poor mechanical and degradation properties. Effective grain size control is a fundamental property of Zn-based alloys that has a significant impact on their mechanical properties and degradation rate through various methodical adjustments of the microstructure. In particular, these critical properties of Zn-based alloys largely depend on grains' size and distribution in the respective microstructures. The review article critically analyses the influence of grain refinement and microstructure on the mechanical properties, biodegradability, and biocompatibility of Zn-based alloys. The article establishes the interdependence between microstructure, mechanical properties, degradation rate, and biocompatibility of both Zn and its alloys. We conclude integration of alloying and fabrication techniques can significantly control grain refinement in Zn-based alloys, and the use of innovative techniques such as dynamic recrystallization and inoculation can further improve the grain refinement process.

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Recent progress in MXenes incorporated into electrospun nanofibers for biomedical application: Study focusing from 2017 to 2022

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ABSTRACT

After discovering a new class of two-dimensional (2D) material, *i.e.*, MXene, a further new scope, came into existence for researchers. Due to their remarkable physical, chemical, and biological properties, MXenes find their role in almost every research discipline. They have been used in biosensors, bioimaging, tissue engineering, drug delivery systems, and other areas. The MXenes can be functionalized with a wide range of atoms/molecules, making them diverse materials. Therefore, the potential of using MXenes in nanofibers can be much more than expected. In this review, we will understand the structure, synthesis, and general properties of MXenes. We will explain using MXenes while encasing them into nanofibers, providing their specific properties. For instance, MXenes-incorporated nanofibers are used in biomedical applications, including soft and hard-tissue engineering and delivery of antimicrobials. Furthermore, MXenes, when incorporated into nanofibers, are used in promoting cellular differentiation, wound healing, and neural tissue restoration, which are briefly discussed in this communication.

1. Introduction

Two-dimensional (2D) materials have remarkable and intriguing physiochemical properties because of their reduced dimensionality [1] and the quantum confinement effect [2]. Moreover, these materials are obtained by top-down exfoliation and/or bottom-up synthesis [3]. They include graphene [4], hexagonal boron nitride [5], and transition-metal dichalcogenides (MoS_2, WS_2, *etc.*) [6]. Further, single-element 2D materials such as phosphorene [7], silicene [8], borophene [9], and others have also been produced [10]. They became the central focus for material scientists since the discovery of 2D graphene [11]. For instance, graphene's high conductivity and in-plane rigidity have unanimously created interest in manufacturing flexible biomedical devices [12]. Similarly, MoS_2 has been used for its drug delivery and in developing the photothermal ability for different applications [13]. In the same context, borophene possesses a wide range of exciting properties, such as lightweight, excellent mechanical toughness, and remarkable superconducting capabilities, increasing its potential in electrical equipment for biomachines [14]. Similarly, black phosphorus nanosheets have distinct energy band configurations, size-dependent band gaps, and semiconductor properties, making them valid by generating electron-hole pairs when exposed to external ultrasounds [15]. However, many of these continue to be studied only for academic purposes; others have gained attention because of appealing features that have led to real-world applications [16]. These include the rapidly expanding class of 2D materials known as MXenes (pronounced "maxenes"), which consists of transition metal carbides and nitrides [17].

Among different nanomaterials, nanofibers are known for various biomedical applications [18]. Fabricating these materials involves numerous methods; however, electrospinning is preferred due to its versatility [19]. The process consists of electrifying a liquid droplet to create a jet, then stretching and elongating to form nanofiber [20]. Various polymeric solutions have been electrospun to obtain desired biocompatible materials, which find their applications, such as in bone [21] and neural [22,23] tissue engineering. Often these materials have been modified to improve their performance while incorporating other nanomaterials [24]. Biomaterials

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Titanium dioxide functionalized multi-walled carbon nanotubes, and silver nanoparticles reinforced polyurethane nanofibers as a novel scaffold for tissue engineering applications

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ABSTRACT

Polyurethane is a synthetic polymer that can be fabricated into nanofibers to mimic extracellular matrix properties facilitating cell attachment and growth on the fibrous network. However, enhanced hydrophilicity and high mechanical properties may improve their use in tissue engineering, suggesting additional modifications are needed. The current work presents the fabrication of polyurethane-based bone regenerative nanofibers reinforced with TiO_2-MWCNT composites and harboring Ag NPs for bacterial inhibition. The fibers possessed smooth morphology with an average size ranging from 800 to 1200 nm. Techniques like SEM, FTIR, XPS, XRD, EDAX, and UV–vis spectroscopy confirmed the presence of nanofiber components like TiO_2-MWCNT and Ag NPs. The Ag NPs' release in PBS was more than 80% over 48 h. The tensile strength and elastic modulus of the nanofibers ranged from 2.1 to 7.1 MPa and 0.53 to 2.39 MPa, respectively. The contact angle demonstrated significant improvement in the hydrophilicity of the nanofibers. These Ag-impregnated fibers controlled bacterial growth, as demonstrated by the disk diffusion and turbidity assays against *E. coli* and *S. aureus*. The MTT test revealed excellent biocompatibility against HEK 293 cells. Finally, compared to the pristine nanofibers, cell growth and attachment are considerably high in the case of modified nanofibers.

Introduction

Bone regeneration is an intricate process involving a series of other steps to heal an injury altogether. Clinically the most critical form of regeneration is the healing of fractures, and the widely used conventional methods include allografts and/or autografts. A novel and efficient approach to improving bone healing is using polymeric biomaterial-based wound dressings, e.g., nanofibrous scaffolds [1,2]. The most significant advantage of such an approach is less invasiveness and local action. The microstructure of the scaffolds mimics the features of natural tissue and its extracellular matrix, supporting the attachment and growth of cells.

In this study, we used polyurethane to fabricate nanofibrous scaffolds, which is an excellent material possessing a wide range of applications, e.g., in manufacturing implants, surgical instruments, healthcare beddings, etc. [3,4]. These have been used to engineer tissues like skin, bone, cartilage, cardiac muscles, blood vessels, nerve tissues, etc. Our group has previously demonstrated the potential of polyurethane nanofibers in tissue regeneration [5–7]. All these applications are owed to the exceptional polymer properties with appropriate biocompatibility and tunable physicochemical properties desired for various biomedical uses. Furthermore, this polymer is bioactive, conductive, and injectable as bone cement, as well as resorbability and osteoinduction properties [8]. The diisocyanate and diol monomers can be altered to improve their thermal and mechanical properties, while functionalization with specific hydrolyzable moieties can increase biodegradability. Besides, polyurethanes also have oxygen

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Electrochemical analysis of glyphosate using porous biochar surface corrosive nZVI nanoparticles†

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Glyphosate [*N*-(phosphonomethyl)glycine] is a widely used phosphonate herbicide for different agricultural purposes. Due to its widespread use, suspected toxicity, and ubiquitous bioaccumulation, it is one of the most harmful contaminants found in drinking water. This demands efficient sensing and removal of glyphosate from contaminated water. Here, we report the decoration of novel and highly porous biochar with nanozero–valent iron (nZVI) nanoparticles to develop an efficient electrochemical sensor for the trace detection of glyphosate. The as-synthesized composite was thoroughly characterized by various state-of-the-art instrumental techniques. The electron micrographs of the composite materials revealed the cavity-like structure and the abundant loading of nZVI nanoparticles. FTIR and XPS analyses confirmed the presence of oxygen-rich functionalities and Fe(0) in the composite nanostructure. Electrochemical analysis through CV, LSV, and DPV techniques suggested efficient sensing activity with a limit of detection as low as 0.13 ppm. Furthermore, the chronopotentiometric response suggested excellent and superior stability for long-term applications. To gain more insight into the interaction between glyphosate and the composite material, DFT calculations were carried out. The Frontier Molecular Orbital study (FMO), Molecular Electrostatic Potentials (MEPs), and Density of States (DOS) suggest an increase in the electron density, an increase in the DOS, and a decrease in the HOMO–LUMO band gap by combining nZVI nanoparticles and biochar. The results suggest more facile electron transfer from the composite for trace detection of glyphosate. As a proof of concept, we have demonstrated that real-time analysis of milk, apple juice, and the as-synthesized composite shows promising results for glyphosate detection with an excellent recovery rate.

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1. Introduction

Though organophosphorus pesticides (OPPs) such as glyphosate were extensively used for agricultural purposes, their suspected toxicity presents a significant challenge to the scientific community.[1,2] Glyphosates are one of the most widely used herbicides to control the growth of weeds, rodents, and long grass because they have been considered eco-friendly for an extended period. However, the consistent usage of glyphosate has resulted in the accumulation of its residues in water bodies, soil, and some foodstuffs. This cumulation of glyphosate has raised risk concerns over crop reliability, and ecological and environmental health.[3] Moreover, the primary degradation product of glyphosate, aminomethylphosphonic acid (AMPA), poses toxicity to humans and affects some vital organs.[4] Therefore, the design and the fabrication of magnetically recoverable composite materials with a promising prospect to detect and remove OPPs are highly desirable.

Several methods such as high-performance liquid chromatography,[5] capillary electrophoreses,[6] and gas chromatography[7,8] have been used to detect glyphosate. Despite their selectivity and high sensitivity, some shortcomings such as high cost and sample pre-treatment limit their use on a large scale.[9] Keeping this in mind, the development of electrochemical sensors has grabbed attention as they offer advantages in terms of a low cost, simple mode of operation, great sensitivity, specificity, and selectivity.[10] It is noteworthy to mention here that glyphosate is not electrochemically active; it becomes difficult to monitor glyphosate without modification of electrodes. In this regard, various materials such as MOFs,[11] chitosan,[12] layered double hydroxides,[13] gold nanoparticles,[14] zeolites,[15] CNTs,[16] and carbon-based electrodes[17] were reported in the literature for the electrochemical monitoring of glyphosate.

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REVIEW

BIOTECHNOLOGY BIOENGINEERING WILEY

Recent trends using natural polymeric nanofibers as supports for enzyme immobilization and catalysis

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Abstract

All the disciplines of science, especially biotechnology, have given continuous attention to the area of enzyme immobilization. However, the structural support made by material science intervention determines the performance of immobilized enzymes. Studies have proven that nanostructured supports can maintain better catalytic performance and improve immobilization efficiency. The recent trends in the application of nanofibers using natural polymers for enzyme immobilization have been addressed in this review article. A comprehensive survey about the immobilization strategies and their characteristics are highlighted. The natural polymers, e.g., chitin, chitosan, silk fibroin, gelatin, cellulose, and their blends with other synthetic polymers capable of immobilizing enzymes in their 1D nanofibrous form, are discussed. The multiple applications of enzymes immobilized on nanofibers in biocatalysis, biosensors, biofuels, antifouling, regenerative medicine, biomolecule degradation, etc.; some of these are discussed in this review article.

KEYWORDS
biocatalyst, biosensor, electrospinning, enzyme immobilization, nanofiber, polymer

1 | INTRODUCTION

Enzymes are biological catalysts with a high degree of specificity. This includes properties of distinguishing between the substrates (substrate specificity), similar parts of molecules (region specificity), and optical isomers (stereospecificity) (Adelt et al., 2003; Ericksen & Szklarz, 2005; Ju & Parales, 2006; Seeger et al., 1999; Van Der Werf et al., 1999; Wołosowska & Synowiecki, 2004). However, the instability and nonreusability of enzymes limit their applications in various fields. Enzyme immobilization into a polymer matrix is an effective strategy to prevent these restrictions. It is pertinent to mention that the enzyme, when immobilized, attaches at multiple points on the support, which contains the undesirable conformational change of enzyme proteins (Datta et al., 2013). Pieces of literature indicate that currently, enzymes are immobilized on macro/micro materials for different applications, such as biosensors, biofuel production, and drug delivery (Garcia-Galan et al., 2011). However, immobilizing enzymes on micro supports comes with undesirable bearings such as distortion of an enzyme's configuration, steric hindrance, and low diffusion rate (Homaei et al., 2013). Henceforth, to overcome these issues and have a better enzyme loading and excellent catalytic efficiency in large-scale processes, it is mandatory to have high surface-area-to-volume ratio support. In this regard, researchers have presented different nanomaterials as a perfect choice of enzyme support (P. Wang, 2006). Therefore, with the advances in nanosciences, nanostructured materials are gaining tremendous importance as supports for enzyme immobilization (Adeel et al., 2018; Ansari & Husain, 2012; Datta et al., 2013; Hyeon et al., 2016; Min & Yoo, 2014; Puri et al., 2013; P. Wang, 2006).

One-dimensional nanomaterials have attained significant attention because of having novel characteristic properties with practical applications. These nanomaterials can be fabricated into different

nanomaterials

MDPI

Article

Nanotextured CeO_2-SnO_2 Composite: Efficient Photocatalytic, Antibacterial, and Energy Storage Fibers

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Abstract: Bacterial infections remain a serious and pervasive threat to human health. Bacterial antibiotic resistance, in particular, lowers treatment efficacy and increases mortality. The development of nanomaterials has made it possible to address issues in the biomedical, energy storage, and environmental fields. This paper reports the successful synthesis of CeO_2-SnO_2 composite nanofibers via an electrospinning method using polyacrylonitrile polymer. Scanning and transmission electron microscopy assessments showed that the average diameter of CeO_2-SnO_2 nanofibers was 170 nm. The result of photocatalytic degradation for methylene blue dye displayed enhanced efficiency of the CeO_2-SnO_2 composite. The addition of SnO_2 to CeO_2 resulted in the enhancement of the light absorption property and enriched charge transmission of photoinduced electron–hole duos, which conspicuously contributed to momentous photoactivity augmentation. Composite nanofibers exhibited higher specific capacitance which may be accredited to the synergism between CeO_2 and SnO_2 particles in nanofibers. Furthermore, antibacterial activity was screened against *Escherichia coli* and CeO_2-SnO_2 composite nanofibers depicted excellent activity. The findings of this work point to new possibilities as an electrode material in energy storage systems and as a visible-light-active photocatalyst for the purification of chemical and biological contaminants, which would substantially benefit environmental remediation processes.

Keywords: CeO_2-SnO_2; environmental remediation; antimicrobial; photocatalyst; supercapacitor

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1. Introduction

Globally, environmental pollution is a serious problem, inflicting harm to life on the planet. Water pollution, among other types of pollution, has a significant negative impact on living species, including aquatic life. Water pollution is due to the discharge of harmful organic chemicals, such as dyes, acids, and antibiotics, into drinkable water bodies, such as rivers, lakes, and ponds, from textile, chemical, and pharmaceutical facilities. In nature, the majority of organic molecules are carcinogenic. Furthermore, water pollution sequentially causes soil pollution, which has a direct or indirect impact on daily living [1,2]. Synthetic color dyes, particularly those generated during textile washes, combine easily with water in comparison to chemicals and reagents; hence, the combination of effluents has hazardous potential. As a result, industrial effluent must be processed prior to being disposed of in the surroundings [3]. Dyes are colored aromatic organic complexes that capture light

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Improvisations to electrospinning techniques and ultrasonication process to nanofibers for high porosity: Ideal for cell infiltration and tissue integration

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ABSTRACT

Electrospinning is considered the most versatile for fabricating nanofibers in tissue engineering applications. Therefore, a bio-inspired morphology (e.g., micro/nanofibers) is highly desirable in which the cells can easily penetrate and increase their number. This can finally lead the synthesized material to be an integral part of a biological system. However, due to 2-D porosity at the surface level and highly compact nature deep inside, these nanofibers obviate cellular infiltration, failing to use them as potential candidates for subsequent tissue integration. Different strategies are put forward for loosening the fibers during and/or after electrospinning to promote cellular penetration into nanofibers. This review will focus on identifying those improvisations made to basic electrospinning techniques yielding highly porous nanofibers, having immense internal permeability, and ultimately resulting in perfect cell growth. The paper will emphasize on creating advanced porosity in the nanofibers using salt-leaching, co-electrospinning, air-impedance, cold-plate electrospinning, and ultrasonication to loosen the individual fibers. Furthermore, this review will give the overall picture of using ultrasonication to yield highly porous nanofibers and its role in modifying as-spun fibers for future technological applications.

1. Introduction

With one of the dimensions at the nano-scale ($\leq$100 nm) and others larger, nanofibers are one of the fascinating classes of nanomaterials. Due to the large surface-to-volume ratio, nanofibers are used in various applications. The remarkable characteristics of nanofibers include a sizable surface area [1], surface functionalization potential [2], and controllable porosity [3]. These exceptional properties make them ideal candidates for fabricating scaffolds for skin, cartilage, and bone construction. Moreover, these nanofibers are used in the construction of blood vessels [4], biosensors [5], and the delivery of fast soluble drugs [6]. The properties of nanofibers, such as preferential control on drug release kinetics [7], the ability to load enzymes [8], antimicrobial peptides [9], antibiotics [10], and growth hormones [11] on the surface, in the core and immobilizing them also count for their biological applications. Moreover, the structural resemblance with the native extracellular matrix due to high interconnected porosity (60–90%) [12], similar crosslinked structure [13], gas permeability [14], along with biocompatibility and biodegradability nature [15] make them ideal candidates for biomaterial applications [13,16]. This paper will give a detailed account of significant advancements made to impart porosity and other desired functionality to nanofibers for biomedical applications using electrospinning and ultrasonication.

There are different techniques by which we can form the 1D nanostructure (e.g., nanofiber) with extraordinary properties. These techniques include electrospinning [17], blow spinning [18], air-jet electrospinning [19], template synthesis [20], centrifugal spinning [21], freeze-drying [22], needleless electrospinning [23], bubble electrospinning [24], melt electrospinning [25], melt blowing spinning [26], template extrusion [27], coaxial electrospinning [28], flash-spinning [29], self-assembly [30], drawing [31], self-bundling electrospinning [32] and emulsion electrospinning [33]. However, electrospinning is the fundamental technique that has dramatically revolutionized the fabrication of nanofibers [34].

In the electrospinning technique, the droplet of fluid emerging from the spinneret serves as one of the electrodes and is subjected to a strong

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Label-free selective and sensitive colorimetric detection of ampicillin in milk and water using silver nanoparticles

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ABSTRACT

Overuse of antibiotics like ampicillin in various developing and industrializing countries leads to the evolution of drug-resistant bacteria and different adverse effects on an individual's health. Though creating a facile, sensitive, and selective method for ampicillin detection is critical, this remains a strategic task. The poly(vinyl alcohol) (PVA)-capped silver nanoparticles (AgNPs) were used to develop a colorimetric assay for the detection of ampicillin. UV-Vis spectroscopy shows a strong peak at 402 nm due to the excitation of surface plasmon resonance (SPR). The X-ray diffraction (XRD) pattern of AgNPs shows lattice planes (111) and (200) correspond to 2θ values of 38.4° and 44.67°, respectively. Transmission electron microscopy (TEM) histogram shows the large number of particles synthesized in the range of 9–13 nm. As-synthesized AgNPs were used to evaluate the selectivity of the assay against various competitive antibiotics. The colour change of the assay mixture from yellow to orange was found in the presence of ampicillin due to target-specific aggregation and localized surface plasmon resonance changed from 402 nm to 550 nm. The limit of detection (LOD) and limit of quantification (LOQ) were found to be 6.2 μM and 18.8 μM (linear range 0.5–10 μM) respectively. The colorimetric assay was used to detect the ampicillin-spiked actual samples (tap water, Yamuna River water, and milk). The developed colorimetric assay provides a real-time, rapid, and easy-to-use platform for detecting ampicillin for real sample analysis.

1. Introduction

Ampicillin is a type of aminopenicillin beta-lactam antibiotic widely used to treat numerous bacterial diseases like gonorrhea, pneumonia, bronchitis, etc. Moreover, it is effective against many gram-positive and gram-negative bacteria (Shrivas et al., 2017). It is susceptible to both gram-positive and gram-negative bacteria, making it favourable for humans and veterinary use with application over a broad range but an animal body can't fully metabolise ampicillin (Abjean and Lahogue, 1997; Chen et al., 2022). Because of the recent increase in demand for meat and milk products, ampicillin is being used in farming to improve livestock production. However, its overdoses bring out the unwanted presence of ampicillin residues in milk and other animal products (Wang et al., 2017). Recently, the extensive use of ampicillin have led to remnants of this antibiotic in food, which indirectly led to bacterial resistance & disturbance in intestinal flora (Zhao et al., 2021). The high concentration of ampicillin due to the consumption of milk and meat products with remnants of ampicillin can also have adverse effects on an individual's health (Abjean and Lahogue, 1997; Chaudhari et al., 2020; Li et al., 2020; Shrivas et al., 2017; Verdon et al., 2000; Wang et al., 2017). To protect human health, most of the countries have established regulations on the permissible residue level for various antibiotics including ampicillin. For the detection of contamination of food and water at the field level, effective detection techniques need to be developed.

Multiple detection methods have been developed to trace the

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A review of protein adsorption and bioactivity characteristics of poly ε-caprolactone scaffolds in regenerative medicine

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Poly ε-caprolactone (PCL)
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ABSTRACT

The failure of transplanted tissues and organs is a major challenge in contemporary regenerative medicine. Biocompatible scaffolds, fabricated from poly ε-caprolactone (PCL), are widely used in tissue engineering strategies to promote tissue and organ growth; however, scaffold biological activity and safety refinement are urgently needed to support their use in clinical practice. PCL scaffolds created in 2-D or 3-D forms have emerged with great potential for the development of tissue regeneration grafts. However, limited bioactivity and surface wettability render PCL scaffolds direct interactions with surrounding tissues. Manipulations of PCL scaffolds may have the potential to overcome these limitations. This review focuses on how scaffold manipulations enhance protein adsorption and can achieve optimized scaffold biocompatibility. From a practical perspective, techniques such as etching or deposition of bioactive compounds can easily modify the surface of the PCL scaffolds. Incorporating bioactive inorganic fillers can be an alternative way to enhance the bioactivity of PCL scaffolds. This review summarizes recent advances in the development of bioactive PCL scaffolds and their applications in regenerative medicine.

1. Introduction

Among many interdisciplinary fields, tissue engineering (TE) is considered a specialized and increasingly advanced scientific domain with an extensive remit in developing health care technology [1,2]. TE strategies promote the regeneration of lost tissue associated with damaged organs due to injury or pathology and transplantation in clinical medicine [3]. This interdisciplinary field brings together biochemical factors, cell technologies, and engineering materials to fabricate artificial tissues. TE scaffolds offer a surface platform for cells to adhere, proliferate and differentiate, ultimately establishing a mature extracellular matrix (ECM). There is a great deal of interest in harnessing the potential for tissue-engineered scaffolds in the field of organ transplantation, given the shortage and increasing need for transplantations among chronically ill patients [4,5]. Therefore, efforts to overcome these barriers by biocompatible transplantable materials and organs derived through tissue engineering synthesis strategies represent a means of overcoming significant obstacles to organ transplantation availability and effectiveness [6,7].

Interest in the use of biological scaffolds to promote tissue and organ growth in the context of transplantation medicine has surged in recent years [8]. However, optimization of these scaffolds is needed to ensure that endogenous tissues grow effectively on the scaffold substrate [9]. Strategies to modify the materials used to manufacture these scaffolds and techniques to promote cellular adhesion and growth in biological tissues formation are vital to ensuring that these tissue engineering techniques are suitable for application in clinical practice [9]. In particular, the use of synthetic scaffold materials and modifications of surface characteristics hold promise in producing tissues and organs that facilitate regeneration transplantation in humans [7,10]. Although scaffolds can be manufactured from various synthetic and natural polymers, this review will focus only on scaffold materials based on a

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Electrospun polyurethane fiber mats coated with fish collagen layer to improve cellular affinity for skin repair

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ABSTRACT

The poor wettability of polyurethane (PU) nanofiber mats hinders their use as a wound dressing. We employed a hydrothermal precipitation approach to coat the extracted and purified fish collagen molecules onto polyurethane fibers. The surface precipitation with 5% and 10% of collagen to the as-spun fibers significantly increased the fiber diameter by about two folds (1.025 ± 0.425 μm to 2.575 ± 0.340 μm). In contrast, the pore size of the composite mat decreased by about 30% at 15% and vanished at 20% of collagen loading. The water contact angle decreased from 84° ± 2.36° to 28.2° ± 2.56°. At the same time, the concentration of the coating solution in the reactor increased from 0% to 20%, demonstrating a significant improvement in the hydrophilicity of PU fiber mats. The proliferation of HdFa reached a maximum of 189.7 ± 4.7% in PU mats coated with 10% collagen. However, mats coated with 15% collagen could provide a better niche for the differentiation of these cells. Higher collagen concentration (20%) resulted in distorted fibroblast morphology. The rate of migration of fibroblasts toward the wound area in the scratch assay was higher on the composite than over unmodified mats and the tissue culture plate. The proposed strategy can be considered a straightforward process to coat the nanofibers of a hydrophobic nature with heat-labile materials like collagen, which have great potential as wound dressing material.

1. Introduction

Wound dressings are essential substitute materials for the successful recovery and healing of skin trauma. Traditional wound dressings such as bandages, gauzes and cotton wool are not efficient in wound healing [1]. Recently electrospun-based nanofiber mats have been used as a replacement for traditional dressings and repair of tissues [2,3]. Nanofibers manufactured using synthetic biodegradable polymers, such as polyurethane (PU), possess excellent spinnability and mechanical properties as requirements as wound dressing substitute materials [4,5]. However, PU has an exceptionally poor surface wettability rendering it useless for skin repair [6]. The insufficient attachment of the PU nanofibers to epithelial tissue due to lack of wettability has been demonstrated in previous literature [7–10].

Nevertheless, natural polymeric materials, such as collagen, have poor mechanical stability and are often challenging to spin into fibers due to their low molecular weight [11]. However, they possess excellent biologically tunable properties for providing a biological niche to the surrounding cells [12,13]. Collagen is one of the main components of the extracellular matrix of human tissues, with excellent biocompatibility and non-immunogenicity [14]. In addition, collagen promotes the attachment, spreading, and proliferation of epidermal cells and

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Recent progress in the green fabrication of cadmium sulfide and cadmium oxide nanoparticles: synthesis, antimicrobial and cytotoxic studies

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ABSTRACT

Interestingly, cadmium sulfide (CdS) and cadmium oxide (CdO) nanoparticles (NPs) are widely used as biosensors, bio-imaging, molecular pathology, solar cells, liquid crystal displays, photovoltaic cells, IR detectors and in drug delivery applications. Salts of Cd can undergo bioreduction by various natural compounds found in microorganisms, such as bacteria, fungi, algae and also in plants, to form NPs. This biological synthesis using enzyme resources has gained tremendous importance due to its environmental friendliness; however, chemical and physical synthesis techniques are frequently employed due to reproducible results in NP formation. This review provides an overview of various reports on synthesizing CdS and CdO nanoparticles and their antimicrobial and cytotoxic activities using bioreduction originating from different sources, e.g., bacteria, fungi, plants (leaves, fruit, flowers and roots), and microalgae. Furthermore, this review comprehensively discusses the significance of green nanotechnology in producing these NPs for various biomedical applications.

1. Introduction

Nanoparticles (NPs) have dimensions less than 100 nm and have attracted much attention due to their outstanding physical and chemical characteristics. Their properties differ from bulk materials because of the large surface-to-volume ratio [1]. In nature, NPs can occur naturally in the environment. For instance, proteins, viruses, silicon dioxide, manganese dioxide, calcium sulfate, iron oxide, sulfur, silver, gold and platinum NPs are present in volcanic eruptions, seawater, iceberg, sulfur wells, ore deposits, automobile exhausts, among others [2]. Synthetic NPs are synthesized by top-down and bottom-up approaches in labs and at an industrial scale, with desired properties for specific applications for human use. However, human exposure and health hazards can still pose severe problems even with proper safety measures. Therefore, the current trend is to use biological synthesis methodologies to replace harmful chemicals through wet chemical processes [3]. In recent years, there has been a lot of research done on a variety of NPs, since they have the most desirable uses in the field of energy devices [4], solar cells [5], environment and sensors [6–9]. However, the ones with the most commercial relevance are semiconductors [10,11]. The literature suggests that diverse cadmium nanomaterials like oxides [12,13], sulfides [14–16], selenides [17,18] and tellurides [19] have been created intra/extracellularly using green synthesis methods in various morphologies. Regardless, the biosynthesis of CdS and CdO as important semiconductors is a fascinating topic requiring additional discussions to comprehend fully.

Furthermore, discrete energy levels, size-dependent optical characteristics, a tunable bandgap, a well-developed synthetic methodology and an easy manufacturing technique with outstanding chemical stability have piqued the attention of CdS NPs among different NPs. With a direct bandgap of 2.5 eV and an indirect bandgap of 1.98 eV, CdO is an *n*-type semiconductor that belongs to the II-VI group [20]. These NPs are attractive candidates for various technical applications, such as liquid crystal displays [21], solar cells [22], infrared detectors, gas sensors [9], photovoltaic devices and photodiodes [23,24]. As in one works, the aqueous extract of *Convolvulus arvensis* was used as the capping agent, while hydrazine acted as the reducing agent in the plant-mediated production of CdO NPs [25]. When H_2O_2 was present, the working

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REVIEW

BIOTECHNOLOGY BIOENGINEERING WILEY

Overview on immobilization of enzymes on synthetic polymeric nanofibers fabricated by electrospinning

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Abstract

The arrangement and type of support has a significant impact on the efficiency of immobilized enzymes. 1-dimensional fibrous materials can be one of the most desirable supports for enzyme immobilization. This is due to their high surface area to volume ratio, internal porosity, ease of handling, and high mechanical stability, all of which allow a higher enzyme loading, release and finally lead to better catalytic efficiency. Fortunately, the enzymes can reside inside individual nanofibers to remain encapsulated and retain their three-dimensional structure. These properties can protect the enzyme's tolerance against harsh conditions such as pH variations and high temperature, and this can probably enhance the enzyme's stability. This review article will discuss the immobilization of enzymes on synthetic polymers, which are fabricated into nanofibers by electrospinning. This technique is rapidly gaining popularity as one of the most practical ways to fibricate polymer, metal oxide, and composite micro or nanofibers. As a result, there is interest in using nanofibers to immobilize enzymes. Furthermore, present research on electrospun nanofibers for enzyme immobilization is primarily limited to the lab scale and industrial scale is still challanging. The primary future research objectives of this paper is to investigate the use of electrospun nanofibers for enzyme immobilization, which includes increasing yield to transfer biological products into commercial applications.

KEYWORDS

biocatalysis, electrospinning, enzyme immobilization, nanofiber

1 | INTRODUCTION

As natural biocatalysts with high specificity and efficiency, enzymes are identified as efficient, safe, and eco-friendly bioprocessing substances that catalyze a wide range of reactions with exceptional selectivity (Schmid et al., 2001). The enzymes' mildness and specificity make them ideal candidates for fine chemical manufacturing, biosensor fabrication, protein metabolism, protein analysis, bioremediation, and food production (e.g., dairy, drinks, oils, meat, baking, and brewing goods) (Basso & Serban, 2019; C. Zhang et al., 2018). However, the industrial usage of enzymes at a large scale is limited due to their high cost, temperature sensitivity, pH limitation, the possibility of inactivation caused by various agents, and arduous recovery from a chemical reaction. To some point, enzyme immobilization is an efficient approach to solve these shortcomings (Brady & Jordaan, 2009; Sheldon, 2007). Immobilization is defined as curbing an enzyme in support or matrix, allowing the interchange of media comprising substrate molecule so that desired product can be formed seamlessly. In other words, immobilization confers the enzyme molecule to solid support over which substrate molecules are transferred and converted to a product. Immobilization of enzymes on inert, insoluble materials is an active area of research for

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RESEARCH ARTICLE

Formulation and Pharmacokinetic Evaluation of Ethyl Cellulose/HPMC-Based Oral Expandable Sustained Release Dosage of Losartan Potassium

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Abstract
Prolonged retention of losartan potassium in the upper gastrointestinal tract is anticipated to increase its absorption and exposure to CYP450 enzyme subfamilies, undertaking its conversion to more potent (10–40 times) active metabolite, losartan carboxylic acid (LCA). Consistent with this, hydroxypropyl methylcellulose K4M/ethyl cellulose–based novel expandable films (EFs) containing losartan potassium (LP) suitable for prolonged retention in the stomach were developed. The films were prepared by solvent casting method. USP type II dissolution apparatus (0.1 N HCl, 37°C, 100 rpm) was used to perform the dissolution testing (drug release, unfolding behavior, film integrity, erosion, and water uptake) of the films. *In vivo* pharmacokinetic studies were carried out in rabbits. An HPLC-UV method was used for the quantification of the drug and its active metabolite in plasma. These folded films placed inside hard gelatin capsule shells unfolded to full dimensions in dissolution medium and provided sustained drug release throughout 12 h. The plasma drug concentration-time curves obtained from the *in vivo* studies were used to determine pharmacokinetic parameters, such as area under the plasma drug concentration-time curve (AUC), area under first moment curve (AUMC), mean residence time (MRT), C_{max}, T_{max}, $t_{1/2}$, k_e, and F_r in comparison with that of the market formulation, Cozaar®. The novel EFs significantly changed the pharmacokinetic parameters of the drug and its active metabolite. The apparent elimination rate constant (k_e) significantly decreased, while MRT and elimination half-life ($t_{1/2}$) increased in both cases. The relative bioavailabilities (F_r) of both LP and E3174 using the novel formulation were higher than that of Cozaar®.

KEY WORDS expandable films · sustained release · gastroretentive · bioavailability · pharmacokinetics

INTRODUCTION

Solid oral dosage forms are the most convenient forms of drug administration, being non-invasive and patient compliant. However, poor absorption through the gastrointestinal tract is a limiting factor for the oral administration of many drugs. Sustained drug delivery is a technique frequently adopted to address this problem (1). These dosage forms release drugs at slower rates allowing more significant time for absorption through the GI tract. However, for drugs with a narrow absorption window (especially in the upper region of the GI) such an approach may not prove efficient (2). Due to short residence time near the main absorption site (*i.e.*, the upper region of GI tract), a large proportion of administered dose gets wasted. In such cases, prolonging the gastric residence time is an alternative for improving the pharmacokinetic profile of drugs. Conventional sustained release dosage forms do not allow sufficient time for this process, so alternative approaches have been devised. Gastroretentive drug delivery offers excellent advantages for drugs that possess a narrow absorption window in the upper region of the GI tract (3). These reside in the stomach for a prolonged period, release the drug in small amounts at a predetermined rate, and allow for comparatively more excellent absorption of drugs.

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Recent Advances in Silver nanozymes: Concept, Mechanism, and Applications in Detection

Sanya Mishra, Abdalla Abdal-hay, Sami ullah Rather, Ravi Mani Tripathi, and Faheem A. Shekh**

Natural enzymes accelerate substrate-specific reactions making them of exquisite interest for various applications. However, their appeal is lost in a practical setting due to low stability and high preparation expenses. This is the primary reason behind the flourishing in the research of nanozyme, i.e., artificial enzymes, in the past decade. Their unique physicochemical properties make them a promising candidate for various applications, especially in diagnostics and detection. They possess an enzyme-like activity and can overcome the drawbacks of natural protein-based enzymes. Nanozymes are nanomaterials that show enzyme-like catalytic activity and have great potential to replace natural enzymes for industrial applications. The scope of tuning these nanozymes enhances their catalytic activity and provides specificity, benefiting disease diagnosis and drug delivery. This review aims to report the applications of silver nanozymes in disease diagnosis, glucose detection, and cancer therapy. Their role in detecting heavy metal ions for environmental safety has also been highlighted.

1. Introduction

The advent of nanotechnology has completely changed the approach of scientific research and development since nanoparticles (NPs) have been observed to possess unique physicochemical properties that are entirely different from those of their bulk counterparts. They have been exploited vigorously for numerous applications, including in medical and nonmedical fields. However, one must not realize it to be a novel technology, as its roots can be traced centuries ago. For instance, copper and silver (Ag) NPs can be dated back to the 9th century, when they were used to shine the ceramic artifacts.[1] One of the earlier and renowned examples is the Lycurgus cup, made by the Romans in the 4th century using Au-Ag alloy NPs to produce greenish-red color.[2] Even though the use of NPs could be found in many such old works of literature; their real potential was not completely understood until 1959, when Richard Feynman delivered the renowned lecture "There's Plenty of Room at the Bottom: An Invitation to Enter a New Field of Physics.[3] This brought in a stream of exceptional studies, and researchers were able to assign quantum size effects as the reason for a change of properties when moving from bulk to nano regime. As things became more and more precise, nanomaterials began to find their extensive role in varied applications. One of the significant applications was their role as enzyme mimetics due to their excellent catalytic properties.

The metabolic reactions in our body are catalyzed by the protein molecules called *enzymes*. It was James B Sumner who, in 1926, established the first enzyme, urease, to be a protein, which won him a Nobel Prize for this discovery in 1946.[4] All the enzymes have been considered protein molecules ever since. However, due to their high production cost and rapid denaturation under variable pH and temperature settings, they have limited their industrial applications.[5] Therefore, a need was felt to develop enzyme mimicking materials, more precisely termed "artificial enzymes" by Robert Breslow.[6] These catalytically active molecules can be anything from polymers, cyclodextrins to supramolecules and dendrimers, showing enzyme-like activity.[7–10] Recently, the discovery of dismutase-like activity of fullerene derivatives[11,12] and peroxidase-mimicking catalysis of Fe_3O_4 NPs[13,14] enunciated the promising career of NPs in the field of biomimetics. The importance and broad prospect of nanozymes can be understood in **Figure 1**. This shows the increasing number of publications each year on nanozymes. These nanozymes have been majorly used

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A comparative review on silk fibroin nanofibers encasing the silver nanoparticles as antimicrobial agents for wound healing applications

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ABSTRACT

The development of multifunctional biomaterials for wound dressings, bandages, tissue scaffolds, etc., has received massive attention in the biomedical field in the last few years. The advanced progress in tissue engineering is the fabrication of smart biomaterials mimicking extracellular matrix (ECM) of human tissue, such as nanofibrous meshes with a micro and nanoporous structure. Silk fibroin (SF) nanofiber is an ideal candidate as a vehicle/substitute material for biomedical utilization due to its several unique properties, including high biocompatibility, biodegradability, and deficient inflammatory reactions. These characteristics make SF a favorable matrix for therapeutic agents. However, unmodified SF could be oxidized quickly, exhibit hydrophobicity, making it inappropriate for biological applications, and inclined to microbial attacks, lessening its applicability. Intensive research is going on to extend the capabilities of SF from hydrophobic material to hydrophilic, from the filament to film, sheet, and scaffolds, and even from soft material to super-rigid material. The researchers have traversed multiple approaches to remodel SF nanofibers to improve the utilization of SF. The threat of infections is inevitable when using SF as wound healing dressing elements or artificial grafts in tissue engineering applications. To confer antimicrobial property to SF, the use of silver nanoparticles and other silver composites is one of the strategies. Silver is a natural antimicrobial agent and has been used since ancient times. Researchers have incorporated silver in the SF nanofibers to impart antimicrobial properties and improve their applications. This review describes the extraction process of SF from silkworms using different methods and their comparative analysis. The electrospinning of SF nanofibers and the important parameters that need to be considered during the fabrication of electrospun SF nanofibers has also been discussed. Furthermore, this review has focused on the current progress in improving SF nanofiber utilizing silver nanoparticles for antibacterial and wound healing applications.

1. Introduction

Silk fibroin (SF) is a natural protein obtained from the silkworm. It can be regenerated in various forms, such as gels [1], powders [2], fibers [3], or membranes [4], depending on the intended applications (Fig. 1). Moreover, the SF products have been used in many biological applications, such as in enzyme immobilization matrix [5], wound dressing [6], vascular prosthesis [7] and artificial grafts [8], because of its controllable degradation and good biocompatibility [9,10]. Being economical, readily available and having an easy extraction protocol SF is used widely in tissue engineering [11]. Nevertheless, the unmodified SF yet lacks the appropriate mechanical strength. It reacts with the surroundings quickly, and its susceptibility to microbial invasions can reduce its applications; consequently, its modifications have become imperative before utilizing it in biomedical applications.

Lately, diverse pharmaceutical dosage forms like nanocapsules, liposomes, hydrogels and nanofibers have been developed to attain a controlled drug release. In this view, the electrospun nanofibers loaded with antibacterial drugs have exceptional advantages such as high loading potential, high encapsulation efficacy and synchronous delivery

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Review article

Overview of printable nanoparticles through inkjet process: Their application towards medical use

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ABSTRACT

Nowadays, the focus on the direct deposition of nanoparticles on different surfaces is quite popular among researchers. In this regard, inkjet printing has become a simple and valuable tool. Although other techniques have been developed for deposition purposes; however, these techniques are unprecise compared to inkjet printing. Some of them need high voltage, work only with particular material, require a high vacuum environment, and other processing parameters are necessary. In contrast, inkjet printing is an efficient method to directly deposit nanoparticles on different surfaces due to its simple working and guided deposition. Moreover, this technique can be used for large-scale deposition of nanoparticles to fabricate various devices. Inkjet printing involves the synthesis of nanoparticle ink, which becomes the prime objective for the ideal deposition of nanoparticles on different substrates. The overall viscosity and surface tension of the nanoparticle inks are essential for effective printing. In this review, we will discuss inkjet printing process, synthesis of different nanoparticle inks (e.g., carbon, silver, graphene, polymer/metal, and metal nanoparticles), and their post-deposition applications pertaining to biomedical use. Being a computer-operated technique for guided deposition of nanoparticles, inkjet printing becomes a minor wastage deposition technique. Moreover, using different substrates as printing material makes this technique quite versatile for deposition, thus increasing the application of printed nanoparticles in various fields.

1. Introduction

The high aspect ratio of nanoparticles results in their enhanced features, such as increased functionalization ability [1], improved antimicrobial activity [2], size-dependent electric [3], and optical properties [4]. Moreover, they provide a handy platform for ideal therapeutics [5], electronics [6], and catalytic applications [7]. There are numerous ways to synthesize nanoparticles, which broadly fall under three categories, i.e., chemical [8], physical [9], and biological routes [10]. The nanoparticles synthesized by these methods must follow their utility in different fields to avail their remarkable properties. In this regard, uniform deposition of these nanoparticles becomes the prime objective to benefit from their remarkable features. For this purpose, numerous deposition technique have been devised such as electrostatic spray [11], spray pyrolysis [12], atomic layer deposition [13], sputter deposition [14], spin coating [15], pulsed laser [16], chemical bath [17], dip-coating [18] and inkjet printing [19]. Moreover, tremendous efforts have been put forward to develop and/or improvise these depositing techniques resulting in the efficient and uniform deposition of nanoparticles.

In electrostatic spray deposition, the liquid is fed to a syringe, and high voltage is applied between the nozzle and the substrate. Eventually, the fluid gets atomized, resulting in very fine droplets, which later on are deposited on the substrate resulting in a thin film formation [11]. Spray pyrolysis is a single-step process in which nanoparticles are layered by the pyrolytic reaction using air pressure for droplet generation [12]. For atomic layer deposition, the substrate is exposed to a gaseous precursor and pulsed into the system alternately to produce a thin film [13]. In the case of sputtering, the nanoparticles are deposited by a bombardment of the target surface with highly energetic particles, resulting in a film deposition [14]. Regarding spin coating, a thin layer of material is deposited via a chemical reaction between liquid phase materials onto

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Regenerated cellulose nanofibers from cellulose acetate: Incorporating hydroxyapatite (HAp) and silver (Ag) nanoparticles (NPs), as a scaffold for tissue engineering applications

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Nanofibers
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ABSTRACT

Cellulose nanofibers, which are troublesome to spin into fibers, can be easily fabricated by post-regeneration of its acetate-derived threads. Cellulose is a natural polymer; it enjoys better biocompatibility, cellular mimicking, and hydrophilic properties than its proportionate analog. Herein, we regenerated acetate-free nanofibers by alkaline de-acetylation of as-spun nanofibers. The resultant cellulose nanofibers previously loaded with hydroxyapatite (HAp) were immobilized using silver (Ag) nanoparticles (NPs) by reduction of adsorbed Ag ions on using sodium borohydride. These amalgamated nanofibers were characterized for SEM, EDX, TEM, FTIR, and hydrophilicity tests revealing the existence of both HAp and Ag NPs in/on the nanofiber scaffolds. The de-acetylation of composite nanofibers resulted in spontaneous hydrophilicity. These nanofibers were cyto-compatible, as resolved by MTT assay conducted on chicken embryo fibroblasts. The SEM of the samples after cell culture revealed that these composites allowed a proliferation of the fibroblasts over and within the nanofiber network, and increased concentration of HAp levitated the excessive of apatite formation as well as increased cell growth. The antimicrobial activity of these nanofibers was assessed on *E. coli* (BL21) and *S. aureus*, suggesting the potential of de-acetylated nanofibers to restrain bacterial growth. The degradation study for 10, 30, and 60 days indicated degradation of the fibers much is faster in enzymes as compared to degradation in PBS. The results certify that these nanofibers possess enormous potential for soft and hard tissue engineering besides their antimicrobial properties.

1. Introduction

In recent years, enormous progress has been achieved and is going on in the area of tissue engineering for the advancement of scaffolds used in various implants. In this regard, the diverse classes of polymers, especially natural and synthetic, have been fabricated to provide a short-term skeleton system for encouraging up the cell attachment, growth, migration, proliferation, differentiation, and finally, procreation to allow regeneration of the impaired tissues [1–3]. However, the natural polymers are ideal candidates in contrast to the counterpart scaffolds created from synthetic polymers [4]. Moreover, the natural polymers have tremendous potential in tissue engineering, regenerative medicine, drug delivery and stem cell-based research [5–7]. Cellulose is an organic polymer with the formula of $(C_6H_{10}O_5)_n$ and is one of the most abundant polysaccharides present on earth. Besides, it is the primary structural component of the cell wall in plants, algae, oomycetes. Intriguingly, some of the bacterial strains are celebrated to synthesize 20-100 nm known as microbial cellulose [8,9]. The utilization of cellulose has been well-documented for various accomplishments in biomedical sciences. Among multiple facets of its application, cellulose as supporting structure in bone/cartilage restoration is accurately used [10,11], vascular tissue reconstruction [12], wound healing [13], diffusion controlling membranes [14] and coating material for drug releasing scaffold [15]. Due to the recent advances in technology, the cellulose is quickly processed into a diverse configuration (e.g., membranes, sponges, particles, and nanofibers) depending upon the method

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Review article

Local dual delivery therapeutic strategies: Using biomaterials for advanced bone tissue regeneration

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ARTICLE INFO

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Bone regeneration
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ABSTRACT

Bone development is a complex process involving a vast number of growth factors and chemical substances. These factors include transforming growth factor-beta, platelet-derived growth factor, insulin-like growth factor, and most importantly, the bone morphogenetic protein, which exhibits excellent therapeutic value in bone repair. However, the spatial-temporal relationship in the expression of these factors during bone formation makes the bone repair a more complicated process to address. Thus, using a single therapeutic agent to address bone formation does not seem to provide a clinically effective option. Conversely, a dual delivery approach facilitating the co-delivery of agents has proved to be a dynamic alternative since such a strategy can provide more efficient spatial-temporal action. Such delivery systems can smartly target more than one pathway or differentiation lineage and thus offer more efficient bone regeneration. This review discusses various dual delivery strategies reported in the literature employed to achieve improved bone regeneration. These include concurrent use of different therapeutic agents (including growth factors and drugs), enhancing bone formation and cell recruitment, and improving the efficiency of bone healing.

1. Introduction

Bone development, regeneration, and repair is a complex process involving many growth factors and biochemical substances [1]. Bone is a vascularised hard tissue constituting part of the skeleton in vertebrates which provides support and protection to body organs and helps in the movement of organisms. Besides, bone also plays a crucial role in regulating pivotal physiological functions, e.g., hemopoiesis, mineral storage, homeostasis, and blood pH [2]. However, the normal functioning of bone is impaired during severe trauma, and by various pathological conditions, such as osteoporosis, osteonecrosis, osteoarthritis, osteogenesis imperfecta, rickets, paget's disease, and bone cancer-causing bone deterioration. Therefore, a serious medical intervention is required to restore its functioning.

To date, the most reliable means of bone repair are autografting or sometimes allografting, which involves the transfer of bone from one area of the body or one person to the other, respectively. However, this method is invasive and has many limitations, including possible morbidity at the donor site, high chances of failure, requiring second surgery, and limited donor sites [3]. Other serious problems associated with grafts are immunological rejection, infection, nerve injury, pain, and disease transmission. Metals like iron, cadmium, cobalt, zinc, titanium, etc., are also used as filling materials in bone defects. These metallic implants also have some limitations like inadequate material-tissue interface, metal erosion, infection, etc. Additionally, since the metals possess greater mechanical strength, these and the metal filler absorb a considerable amount of mechanical stress and thus halt the stress-induced bone formation [4]. Other treatment options for bone defects are ceramics which are the inorganic bioactive materials resembling the constituents of bone, e.g., hydroxyapatite, tricalcium phosphate, ceramic pastes, etc. [5]. Although these bioactive ceramic materials offer excellent alternatives for bone repair owing to their biocompatibility, due to their brittle nature and slow degradation, these cannot provide adequate support at the defect site. Considering the above-mentioned facts, newer strategies have been employed to overcome these drawbacks and provide a better means of bone healing. These approaches include growth factor delivery, cell transplantation, gene therapy, biomimetic scaffolds, etc.

Among the therapeutic agents used for bone regeneration, growth factors have received considerable attention. The most common growth

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Immobilization of bioactive glass ceramics @ 2D and 3D polyamide polymer substrates for bone tissue regeneration

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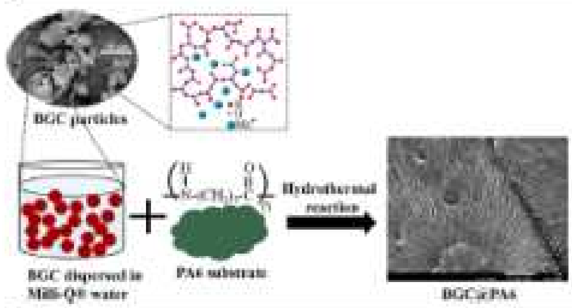
HIGHLIGHTS

- Formation of bioactive glass-ceramic (BGC) on casting, 3D printing and electrospun nanofibers polyamide 6 (PA6) substrates.
- Highly ordered and aligned BGC nanoneedle on the outer surface of PA6 substrates by ion dissociation was developed.
- BGC@PA6 exhibited superior osteogenic differentiation and activity of MC3T3 cells.
- *In-situ* immobilization of BGC enhances substrate biofunctionality towards bone regeneration.

GRAPHICAL ABSTRACT



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ABSTRACT

The osteoinductivity of bioactive glass ceramics (BGCs) is dependent on their ability to effectively interact with the surrounding physiological environment and influence the fate of target cells; however, masking and poor dispersion can negatively influence bioactivity. Here, we address this problem via a simple fabrication method of assembling highly ordered and aligned arrays of BGC nanoneedle-like structures (@) on the outer surface of various polyamide 6 (PA6) substrates (casted film, 3D printing filaments, electrospun fibre mats) by ion dissociation. The staggered-like nanoneedles of BGC@PA6 substrates with excellent uniform dispersion showed favourable cell viability, proliferation, and spreading of MC3T3 osteoblast-like cells. Moreover, the immobilized BGC nanoneedles induced osteogenic differentiation and accelerated the expression of late osteoblast marker genes, compared to the control group. Furthermore, the BGC@PA6 composite showed high affinity for bone-like apatite formation when incubated in physiological body fluids. These findings suggest that the unique dispersion of BGCs@PA6 substrates with nanostructure features make them attractive candidates for bone tissue regeneration and open avenues for future investigation into exploiting these properties for bone tissue engineering. Importantly, this work provides a novel concept for *in-situ* immobilization of BGC with distinctive topographical features onto polymer substrates simulating natural bone structure.

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Polyelectrolytic nature of chitosan: Influence on physicochemical properties and synthesis of nanoparticles

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ABSTRACT

Chitosan is an excellent polymer that has been exploited for biomedical applications ranging from antimicrobial action to targeted drug delivery and tissue engineering. Chitosan has been chiefly used to develop formulations in the form of conjugates, nanoparticles, hydrogels and scaffolds. However, being a polyelectrolyte, the charge density and various physicochemical properties, such as solubility, viscosity, mucoadhesion, and swelling of chitosan, are extremely sensitive to variation in external conditions (e.g., pH and ionic strength of the medium). This review discusses chitosan's physicochemical properties in the solution like solubility, viscosity, mucoadhesion, and swelling, which are a function of its polyelectrolytic nature. Furthermore, the effect of specific parameters like pH and ionic strength of the medium on the polymer and nanoparticle synthesis is also discussed. During formulation development process the charge density on chitosan plays a crucial role in determining the final product's efficiency. Finally, we conclude that the effectiveness of cellular adherence of chitosan hydrogels or scaffolds, the biodistribution of nanoparticles, and the antimicrobial action of chitosan are all functions of its surface charge density.

1. Introduction

Chitosan is a biocompatible and biodegradable derivative of chitin. It possesses various molecular weights (3000–20,000 Da) and is characterised by varying acetylation degrees. Chitosan has gained a remarkable place in medicine by maintaining its excellent pharmaceutical and biomedical applications [1]. Moreover, nanotechnology has further widened its scope for treating various diseases and allowed the development of nanoparticles, nanofibers, hydrogels for targeted drug delivery, imaging, and tissue engineering purposes [2–7]. Biocompatible polymers are preferred due to their favorable tissue integration properties. Chitosan consists of randomly distributed β-(1 → 4)- linked to D-glucosamine (deacetylated units) and *N*-acetyl-D-glucosamine (acetylated units) (Fig. 1). The deacetylation introduces one amine group per D-glucosamine unit. It is noteworthy to mention that the introduction of amine groups in chitosan imparts substantially fair physicochemical and pharmacokinetic properties to nanoparticles [8–10]. These applications are primarily ascribed directly or indirectly to the amine groups' presence and chitosan's polyelectrolytic nature. Amine groups' existence allows chitosan to undergo extensive protonation in aqueous media, which permits electrostatic interaction with solvent molecules, additives, and/or biological sites. Some of the critical physicochemical properties of aqueous chitosan systems like solubility, viscosity, mucoadhesion and swelling have been explained based on this electrostatic interaction. Moreover, this property of chitosan has been exploited to synthesize nanoparticles through ionic gelation, which is widely used for this purpose.

Now that the electrostatic charge density arbitrates the chitosan's various properties, any change in the process conditions that affect its charge density is imperative to alter the final product's properties and functioning. Consequently, several process variables, especially pH and counter ionic strength, change chitosan nanoparticles' physicochemical properties [11–13]. This alters some of the fundamental characteristics such as the size, zeta potential, and polydispersity of nanoparticles, significantly affecting their cellular uptake and biodistribution. Owing to their properties, such as amenable size and surface charge, it is possible to deliver drug-containing nanocarriers to distant organs, tissues, or deep sites inside the body. For example, a shift in pH may change particle size and surface charge enormously. A slight increase or decrease in the surface charge may affect nanoparticles' stability by many folds [14], which significantly influences the biodistribution of nanoparticles.

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Green Synthesis, Spectroscopic Characterization and Biomedical Applications of Carbon Nanotubes

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Abstract

Carbon nanotubes are nano-sized cylindrical chicken wire-like structures made of carbon atoms. Carbon nanotubes have applications in electronics, energy storage, electromagnetic devices, environmental remediation and medicine as well. The biomedical applications of carbon nanotubes can be owed to features like low toxicity, non-immunogenicity, high in vivo stability and rapid cell entry. Carbon nanotubes have a great prospect in the treatment of diseases through diagnostic as well as therapeutic approaches. These nanostructures are interesting carriers for delivery and translocation of therapeutic molecules e.g. proteins, peptides, nucleic acids, drugs, etc. to various organs like the brain, lungs, liver, and pancreas. Commonly used methods to synthesize carbon nanotubes are arc discharge, chemical vapor deposition, pyrolysis, laser ablation etc. These methods have many disadvantages such as operation at high temperature, use of chemical catalysts, prolonged synthesis time and inclusion of toxic metallic particles in the final product requiring additional purification processes. In order to avoid these setbacks, various green chemistry-based synthetic methods have been devised, e.g., those involving interfacial polymerization, supercritical carbon dioxide drying, plant extract assisted synthesis, water- assisted synthesis, etc. This review will provide a thorough outlook of the eco-friendly synthesis of carbon nanotubes reported in the literature and their biomedical applications. Besides, the most commonly used spectroscopic techniques used for the characterization of carbon nanotubes are also discussed.

Keywords: Carbon nanotubes; biomedical applications; green synthesis; natural carbon precursors; spectroscopy; therapeutic carriers.

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ARTICLE

Applied Polymer SCIENCE WILEY

Synthesis, characterization, and cell viability of bifunctional medical-grade polyurethane nanofiber: Functionalization by bone inducing and bacteria ablating materials

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Abstract

There is an extensive possibility of improving characteristics of fibers used in hard tissue engineering, being hydrophobic and less osteoconductive, resulting in the dynamic growth of new tissues. The current work focuses on the fabrication of nanofibers incorporated with titanium dioxide (TiO_2) "as osteoconductive" and silver (Ag) "as self-healing" nanoparticles (NPs). The incorporation of $AgNO_3$ by in situ method not only helped to impart the antibacterial activity but also changed the contact angle from $81 \pm 03°$ in the case of pristine nanofibers to $74 \pm 03°$, $61 \pm 03°$, $50 \pm 08°$, and $39 \pm 1.1°$, in the composite scaffolds containing 0.01, 0.03, 0.05, and 0.07 M of Ag salts. The incubation in simulated body fluid at 37°C to induce mineralization on nanofiber scaffolds indicated Ca and P crystals' formation. The antibacterial activity showed significantly more toxicity toward *E. coli* (8.3 ± 0.9 mm) than *S. aureus* (1.2 ± 0.1 mm). Biocompatibility studies using MTT assay on the pre-osteoblasts showed that both TiO_2 and Ag NPs present in the nanofibers are non-toxic to the bone-like cells. However, results show that a higher concentration of Ag NPs (i.e., 0.07 M) is toxic to cells growing. Finally, all the results suggest that the nanofiber scaffolds have considerable scope for future bone tissue engineering materials.

KEYWORDS
biodegradable, biomaterials, biomimetic, colloids, fibers

1 | INTRODUCTION

To date, scaffolds used for hard tissue engineering have attracted enormous attention due to their lightweight and mechanical biomimicry. These unique structures of scaffolds are fabricated to offer intriguing biocompatibility and biodegradability.[1] On the one hand, biocompatibility is an essential characteristic that provides a platform for fewer immunological responses from neutrophils, macrophages, monocytes, and so on.[2] On the other hand, biomaterial should be completely degradable so that after the scaffold is fixed, it will eventually degrade simultaneously, and newly formed tissue will interchange the structure eternally. In addition to these attributes, the designed scaffolds should mimic the natural extracellular matrix present in the mammalian body. In nature, the extracellular matrix comprises viscous proteoglycans and adhesive fibrous proteins (e.g., collagen) for the cells' surface binding, thereby providing a reliable scaffold.[3–5] Typically, for the growth of hard tissue, scaffolds should

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Natural mulberry biomass fibers doped with silver as an antimicrobial textile: a new generation fabric

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Abstract

In this study, silver-doped natural mulberry fibers were successfully obtained by the dip-coating technique. Arrays of material consisting of synthetic compounds (organic as well as inorganic) are being utilized to impart antimicrobial functionality to textiles. Therefore, the current study for the first time attempted to establish an innovative class of textiles made up of silver-doped natural mulberry fibers. This fabric will be utilized for the fabrication of antimicrobial socks. The morphology, physicochemical and antibacterial characteristics of Ag-doped mulberry fibers were scanned via X-ray diffraction (XRD), scanning electron microscopy (SEM), electron probe microanalysis, Fourier transform infrared spectroscopy (FTIR) and antibacterial testing. SEM analysis evidently demonstrated uniform distribution of Ag on mulberry fibers and the outcome of XRD and FTIR analyses authenticated assimilation of Ag in the Ag-doped mulberry composite. The Ag-doped mulberry fibers revealed venerable antibacterial action against representative bacterium *E. coli*. The antibacterial analysis lead to the conclusion that the Ag-doped mulberry fiber textile has an enhanced bactericidal effect owing to the synergism of Ag and mulberry compounds. Moreover, Ag imparted an anti-odor effect on mulberry fiber. These distinctive organic–inorganic fibrous composite socks are antimicrobial, odor free and skin and environment friendly. Thus, this study recommends the use of Ag-doped mulberry fibers as a future material for the preparation of durable antibacterial new generation socks. These composite fibers can also be used as textile material for clothes such as sportswear and for medical purposes; for instance, bedcovers in hospital beds, etc.

Keywords

Organic–inorganic composite, mulberry, nanofabric, antimicrobial, silver

Textiles are among the basic necessities of life and are used throughout the globe for diverse purposes on a daily basis. In particular, nowadays natural fiber composites have proven tempting to the textile market; therefore, natural fibers have become exceedingly worthy materials.[1] Natural fibers, such as jute, kenaf, hemp, sisal, etc., are repeatedly being utilized as reinforcing material in polymer matrices.[2] Nevertheless, principally, the use of natural products has appreciably decreased the environmental burden and has facilitated waste removal. Generally, mulberry trees are cultivated for rearing silkworms. Concurrently, the mulberry bark is being exploited for paper making as well as supplements in optical and drug companies and use in fabric factories.[3] On the other hand, thousands of mulberry branches consisting of basts and stalks are simply

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catalysts

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Review

Strategies to Use Nanofiber Scaffolds as Enzyme-Based Biocatalysts in Tissue Engineering Applications

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Abstract: Nanofibers are considered versatile materials with remarkable potential in tissue engineering and regeneration. In addition to their extracellular matrix-mimicking properties, nanofibers can be functionalized with specific moieties (e.g., antimicrobial nanoparticles, ceramics, bioactive proteins, etc.) to improve their overall performance. A novel approach in this regard is the use of enzymes immobilized onto nanofibers to impart biocatalytic activity. These nanofibers are capable of carrying out the catalysis of various biological processes that are essential in the healing process of tissue. In this review, we emphasize the use of biocatalytic nanofibers in various tissue regeneration applications. Biocatalytic nanofibers can be used for wound edge or scar matrix digestion, which reduces the hindrance for cell migration and proliferation, hence displaying applications in fast tissue repair, e.g., spinal cord injury. These nanofibers have potential applications in bone regeneration, mediating osteogenic differentiation, biomineralization, and matrix formation through direct enzyme activity. Moreover, enzymes can be used to undertake efficient crosslinking and fabrication of nanofibers with better physicochemical properties and tissue regeneration potential.

Keywords: nanofibers; enzyme immobilization; biocatalysis; tissue repair; extracellular matrix

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1. Introduction

Nanofibers can be of synthetic or natural origin, which are preferably fabricated through a technique termed electrospinning. Electrospinning affords us 1D nanomaterials in the form of micro and nanofibers. Nanofibers have attained a premier place in the field of tissue engineering and are the main focus of current regenerative medicine owing to their remarkable extracellular matrix-mimicking functional properties [1–3]. Nanofibers can be functionalized with additional moieties to impart specific properties in addition to their inherent tissue regenerative properties [4–6]. Nanofibers have been studied and successfully evaluated for different uses because of their textured microstructure, which imparts high surface area. The unique structural features and the increased surface area to volume ratio, controllable pore size, biomimetic morphology, and the presence of interconnected pores present in nanofibers suggest efficient delivery of bioactive compounds through nanofiber.

Nanofibers support enzyme immobilization, which can improve enzymes' performance by increasing surface area, mass transfer resistance, loading efficiency, and the possibility of recycling the enzymes after catalytic performances. The primary emphasis after fabrication of nanofibers so far, however, has been mainly on improving their mechanical properties, cellular adhesion, and biocompatibility. Nevertheless, several studies have used bioactive proteins in nanofibers as moieties for triggering signaling pathways

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Review

Prospects of Polymeric Nanofibers Loaded with Essential Oils for Biomedical and Food-Packaging Applications

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Abstract: Essential oils prevent superbug formation, which is mainly caused by the continuous use of synthetic drugs. This is a significant threat to health, the environment, and food safety. Plant extracts in the form of essential oils are good enough to destroy pests and fight bacterial infections in animals and humans. In this review article, different essential oils containing polymeric nanofibers fabricated by electrospinning are reviewed. These nanofibers containing essential oils have shown applications in biomedical applications and as food-packaging materials. This approach of delivering essential oils in nanoformulations has attracted considerable attention in the scientific community due to its low price, a considerable ratio of surface area to volume, versatility, and high yield. It is observed that the resulting nanofibers possess antimicrobial, anti-inflammatory, and antioxidant properties. Therefore, they can reduce the use of toxic synthetic drugs that are utilized in the cosmetics, medicine, and food industries. These nanofibers increase barrier properties against light, oxygen, and heat, thereby protecting and preserving the food from oxidative damage. Moreover, the nanofibers discussed are introduced with naturally derived chemical compounds in a controlled manner, which simultaneously prevents their degradation. The nanofibers loaded with different essential oils demonstrate an ability to increase the shelf-life of various food products while using them as active packaging materials.

Keywords: electrospinning; essential oils; food industry; wound healing; tissue engineering

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1. Introduction

Phytochemicals are compounds that help plants to defend against microbes, insects, and other animals. When these phytochemicals are subjected to isolation from medicinal plants and then used in the form of plant extracts, they can have a lot of therapeutic importance [1–3]. The primary active compounds of the plant extracts include antioxidants and antimicrobials. However, the antimicrobial attributes of plant extracts are of significant interest nowadays [4–6]. The uncontrolled and massive utilization of synthetic compounds, such as antibiotics in cosmetics, medicine, pharmaceutics, and the food industry, is causing environmental concerns [7–9]. Interestingly, plant extracts have been largely used to treat microbial infections due to their inherent ability to treat synthetic antibiotic-resistant infections [10–14]. The efficient extraction and delivery of phyto-compounds (e.g., essential oils) to patients from medicinal plants is a great challenge for researchers with regard to use them as antimicrobial agents. The antimicrobial agents, e.g., essential oils, have an exclusive position to treat various diseases. However, the polymer matrix also performs a critical function in delivering the same. To achieve this goal, various polymers are used to provide a suitable vehicle system to deliver essential oils. These polymers are used primarily in the form of nanomaterials with different dimensions (e.g., 0-D, 1-D, 2-D, and

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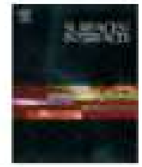

Citrate coated magnetite: A complete magneto dielectric, electrochemical and DFT study for detection and removal of heavy metal ions

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ABSTRACT

The super paramagnetic iron oxide nanoparticles (SPIONs) such as magnetite (Fe_3O_4) appear as an emerging class of materials in the field of environmental remediation owing to its biocompatibility, high surface area, super paramagnetic properties and ease of reuse and recovery. However, susceptibility of bare Fe_3O_4 to oxidation and agglomeration limits its use as an adsorbent material in aqueous medium, which demands the surface capping of these Fe_3O_4 nanoparticles for effective adsorption performance. We have successfully capped Fe_3O_4 with sodium citrate with a purpose to develop a felicitous magnetic sorbent material containing abundant metal trap centers at its surface. The successful surface modification of Fe_3O_4 with citrate is noticeable from FT-IR, TGA, XRD, Zeta potential (DLS), SEM, EDX,TEM, DR-UV, and contact angle measurements. For the first time, we report electrical impedance spectroscopic studies on this capped magnetic nanoparticle to understand the capacitive behavior of super paramagnetic Fe_3O_4 and citrate@Fe_3O_4 nanoparticles. The cyclic voltammograms manifested the excellent electrochemical response of citrate@Fe_3O_4 modified glassy carbon electrode to mM concentrations of Pb^{2+}, Cd^{2+} and Zn^{2+} ions with response in order $Pb^{2+} > Cd^{2+} > Zn^{2+}$. Differential Pulse Voltammetry confirms the descent sensitivity towards Pb^{2+} ions at different concentration with a 0.3 μM detection limit. The adsorption of Pb^{2+} ions followed Langmuir isotherm model with maximum monolayer adsorption capacity of 58.93 mg g^{-1}. To further validate the experimental adsorption results and the mode of interaction between Pb^{2+} and citrate@Fe_3O_4, quantum calculations using density functional theory were performed which indicate a good coherence between experimental and theoretical data. The presence of abundant carboxyl and hydroxyl metal trap centers at the surface of citrate@Fe_3O_4 is responsible for its promising adsorption capacity for Pb^{2+} ions removal. Both experimental as well as theoretical results suggest that surface functionalization has a positive impact for detection of heavy metal ions and should be given prime importance while designing absorbent materials. The citrate@Fe_3O_4 nanoparticles exhibit outstanding stability and regeneration over various cycles of sorption.

1. Introduction

With the rapid pace of industrialization, the problem of water contamination has become a more serious issue globally. Statistical predictions demonstrate that over 1000 million people living in arid regions will be confronted with clean water scarcity by 2025. Among the various hazardous pollutants in water, heavy metal ions such as Hg^{2+}, Cd^{2+}, Pb^{2+} and Zn^{2+} have raised much concern due to their well-known toxic nature and resistance to direct biological treatment. These heavy metal ions originate from combustion of fossil fuels, discharge of effluents from various industries, such as chemical manufacturing, smelting, electroplating, textile, alloy manufacturing, and lead storage battery [1-3]. Though, metals are important for the physiochemical functioning of our body, their concentration has great influence on living bodies. In quantities larger than required by biological systems, they are prone to be fatal and become a source of interference with the normal biological processes occurring within the body [4-6]. For example, lead is a cumulative poison and the excessive uptake of this metal is reported to cause damage to the nervous system, reproductive system, cardiovascular system, and the genital system [7,8]. On the

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Review article

Recent advances in formulating electrospun nanofiber membranes: Delivering active phytoconstituents

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ABSTRACT

Extracts derived from plant origin have been used in clinical practice for the management of burn injuries, wounds and different medical ailments, dating back many centuries. In current modern practice, the application of plant-based extracts has been extended to repair and/or regenerate soft to hard tissues using nanotechnology. Lately, the evolution of polymeric scaffolds by electrospinning technique has expanded the scope of plant-based extract in exploitation to various biomedical fields. In this work, an exhaustive literature survey was conducted out by means of scientific engines and databases such as Google Scholar, PubMed, ScienceDirect and MEDLINE. The articles published between 1933 and 2018 were included in this study to investigate the applicability of plant-based extracts using nanofibers as keywords. This review recapitulates the implementation and recent advances of plant extract incorporated in nanofibers for the domains of tissue engineering, drug delivery and wound healing. Furthermore, these scaffolds provide a high degree of porosity ensuing in the large surface area accessible for cell attachment and infiltration, gaseous/waste exchange and nutrient mobilization. These scaffolds also represent as mats to assist as skin graft replacement for proper application of the affected areas at burn sites. These scaffolds provide innovative means of encapsulating the phytoconstituents and additional options to synthetic replicas used in wound management and drug delivery. However, novel strategies need to be endorsed for large-scale generation of the fibers and succeeding in clinical translation of these outcomes.

1. Introduction

Plant-derived natural outcomes have been extensively used since ancient times for treating various diseases. In the era of contemporary medicine, herbal formulations are known to exert a positive influence on inflammation, fibroplasia, epithelization, collagenation and wound contraction [1–3]. The outcomes from medicinally significant herbs has led to the development of various pharmaceutical formulations intended for various ailments [4,5]. Recently, these products have also been employed in various advanced fields of tissue engineering including that of bone, nerve and skin regeneration [6–10]. Nevertheless, natural products have demonstrated to be extraordinarily efficacious in curing various disease and ailments. Therefore, many practitioners with experience in modern medicine have opted this preferred medication system to treat their patients with herbal remedies [11,12]. Moreover, it is approximately estimated that 25% of prescription drugs are either composed of medicinal plant extracts and/or plant-derived natural products [13]. Currently, the plant-based extracts have even been employed to treat prostate cancers and are commercially available [14]. Many techniques have been full-fledged to deliver herbal products inside the human body for treating different disorders. The traditional course of delivering these formulations include tablets [15], capsules [16], syrups [17], solutions [18] and decoctions [19], whereas, the modern procedures include mouth dissolving tablets [20], matrix tablets [21], microgranules [22], mucoadhesive systems [23], transdermal films [24], retentive buccal systems [25], aerosols [26], microparticles [27], microcapsules [28], nanoparticles [29], sustained release implants [30], nanomicellar systems [30] and colloidal nanogels [31].

In addition to these approaches, the contemporary focus is on the delivery of natural products to targeted disease sites, and the development of tissue engineering techniques to transform the current drug delivery system [32–34]. It is notable in mentioning that the challenge in the delivery of a natural product at a targeted site relies on attaining the ideal bioavailability. In this regard, the nanocarriers (e.g.,

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Review

Electrospun nanofibers for the delivery of active drugs through nasal, oral and vaginal mucosa: Current status and future perspectives

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ABSTRACT

Transmucosal surfaces bypass many limitations associated with conventional drug delivery (oral and parenteral routes), such as poor absorption rate, enzymatic activity, acidic environment and first-pass metabolism occurring inside the liver. However, these surfaces have several disadvantages such as poor retention time, narrow absorption window and continuous washout of the drug by the surrounding fluids. Electrospun nanofibers with their unique surface properties and encapsulation efficiency may act as novel drug carriers to overcome the challenges associated with conventional drug delivery routes, so as to achieve desired therapeutic responses. This review article provides detailed information regarding the challenges faced in the mucosal delivery of drugs, and the use of nanofiber systems as an alternative to deliver drugs to the systemic circulation, as well as local drug administration. The physiological and anatomical features of different types of mucosal surfaces and current challenges are systematically discussed. We also address future considerations in the area of transmucosal delivery of some important drugs.

1. Introduction

In recent times, mucosal delivery has been explored as an alternative method for systemic delivery of drugs with numerous benefits over conventional methods (oral and parenteral routes). This mode of drug delivery involves the penetration into multiple layers of epithelial cells overlying a loose connective tissue (oral, nasal and vaginal mucosa). However, accomplished delivery of drugs to mucosal layers still poses a significant challenge. Moreover, the feasibility to deliver not only small drug molecules but even so the large molecules and/or nanoparticles alongside evokes a greater ultimatum. To achieve the effective delivery of drugs through the mucosal barriers, the bountiful strategies involve the development of rapidly-dissolving systems, nanomaterials with mucous penetrating properties and fabrication of mucoadhesive materials, among others. However, other additional challenges for successful entry of the drug molecules across the mucosal tissue are yet to be solved. For example, the water insolubility of few important drugs and the complex chemical structure of latest bioactive compounds poses considerable challenges. Other considerations include anatomical issues such as the flexibility of mucosal surfaces, blood flow to the mucosa, the flow of body fluids to the mucosal site, the presence of mucosal absorption barriers and keratinization of certain mucosal surfaces.

Polymeric nanofibers have gained significant attention in delivery of drug molecules owing to their promising properties; for example, the large surface-area-to-volume ratios and resultant abundant porosities leading to high loading efficiency (especially in woven mats). The nanofibers are mainly fabricated via electrospinning technique and have considerable applications for tissue engineering, wound dressing, sensors, filtration aid and drug delivery repositories [1–9]. Nanofibers as pharmaceutical repositories have been extensively researched in the delivery of active drugs, therapeutic proteins and gene delivery [10]. In the context of "nanofibers as drug delivery systems", many reviews are available in the current research domain [1], yet there is an extensive need to uncover the potential of nanofiber systems as mucosal delivery systems as a subset to drug delivery in general. This is particularly because of the ease for applicability to fabricated fibers at different mucosal sites, high permeation rate of the drugs via mucosal sites and availability of huge specific surface areas. Also, nanofiber materials can further be tailored to specific applications by changing the composition and surface modifications (e.g., physical and/or chemical grafting of ligand molecules to tackle some of the difficulties for delivering drugs

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The Role of α, γ, and Metastable Polymorphs on Electrospun Polyamide 6/Functionalized Graphene Oxide

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The present paper describes the addition of nitroxide-functionalized graphene oxide (GOFT) into polyamide 6 (PA6) micro- and nanofibers, which are obtained through electrospinning. Scanning electron microscopy micrographs demonstrate the presence of fibers. Tensile testing presents an unexpected and non-obvious behavior, in which the Young's modulus, tensile strength, and elongation simultaneously and remarkably increase compared to the pristine polymer nanofibers. GOFT induces the hydrogen bonding between the NH group from PA6 with the functional groups, thus promoting higher crystallinity of the polymer matrix. Nonetheless, deconvoluted curves by differential scanning calorimetry reveal the presence of two quasi-steady polymorphs (*β* and *δ* phases) contributing to 46% of the total crystallinity. This evidence suggests that their presence and high ratios are responsible for the unexpected and simultaneous enhancement of tensile properties.

Polyamide 6 (PA6 or Nylon 6) is a semicrystalline polyamide that can be processed into films, plastics, and fibers,[1] it finds applications in the automotive, food packaging, sports, and textiles industries. Fibers of this polymer are used in parachutes,[2,3] automobiles, and aircraft tire cords.[4,5] Holmes recognized in 1955 that Nylon 6 presented different crystal structures,[6] which are now identified as the *α* phase (thermodynamically preferred) and the *γ* phase. The *α* crystal is monoclinic and forms hydrogen bonds between antiparallel fully extended chains, while the *γ* crystal is also monoclinic but the hydrogen bonds are established between parallel pleated chains.[7,8] It is common to encounter both crystalline phases coexisting, but a phase can be favored under proper processing conditions. For example, the *α* crystal is obtained from solution crystallization or slow cooling from the melt, while the *γ* crystal is obtained with I_2/KI treatment.[9,10] Interconversion of these phases is also possible under annealing or drawing conditions.[11–13] In addition to these phases, mesomorphic crystal forms (*β* or *δ* phases) have been observed experimentally and predicted by MSXX force field. Although there is disagreement in the literature as to the existence of one or several of these metastable phases, it is recognized that intermediate crystal structures that present intermediate conformational features between the *α* or *γ* crystals occur.[14–16] Identification of these intermediate polymorphs is elusive by X-ray diffraction patterns and fourier-transform infrared spectroscopy (FTIR) spectra because these are similar to the more stable *α* and *γ* phases, and their interconversion into the latter structures further complicates their analysis.

Electrospinning is the most studied fiber forming technique that produces micro- and nanofibers. It consists of placing a polymer solution in a syringe equipped with a needle or capillary tube attached to a high-power source, which generates a high voltage difference between the needle and a grounded target, usually in the range 5–30 kV. As the polymer solution is ejected from the syringe, the electrical charges on the polymer and the solvent induce evaporation of the latter, simultaneously promoting a charge repulsion that elongates and creates a thin polymer fiber. Finally, the dry polymer fiber travels to deposit on a grounded target.[17,18]

Nanotechnology and the acknowledgement that smaller fiber diameters offer high aspect ratio and enhanced mechanical properties[19] is the driving force for the interest in this technique.[20]

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ORIGINAL ARTICLE

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Fabrication of multifunctional cellulose/TiO_2/Ag composite nanofibers scaffold with antibacterial and bioactivity properties for future tissue engineering applications

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Abstract

In the present work, a novel strategy was explored to fabricate nanofiber scaffolds consisting of cellulose assimilated with titanium dioxide (TiO_2) and silver (Ag) nanoparticles (NPs). The concentration of the TiO_2 NPs in the composite was adjusted to 1.0, 1.5, and 2.0 wt % with respect to polymer concentration used for the electrospinning of colloidal solutions. The fabricated composite scaffolds were dispensed to alkaline deacetylation using 0.05 M NaOH to remove the acetyl groups in order to generate pure cellulose nanofibers containing TiO_2 NPs. Moreover, to augment our nanofiber scaffolds with antibacterial activity, the in situ deposition approach of using Ag NPs was utilized with varied molar concentrations of 0.14, 0.42, and 0.71 M. The physicochemical properties of the nanofibers were identified by scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared (FTIR) and contact angle meter studies. This demonstrated the presence of both TiO_2 and Ag NPs and complete deacetylation of nanofibers. The antibacterial efficiency of the nanofibers was scrutinized against *Escherichia coli* and *Staphylococcus aureus*, revealing proper in situ deposition of Ag NPs and confirming the nanofibers are antibacterial in nature. The biocompatibility of the scaffolds was accustomed using chicken embryo fibroblasts, which confirmed their potential role to be used as wound-healing materials. Furthermore, the fabricated scaffolds were subjected to analysis in simulated body fluid at 37°C to induce mineralization for future osseous tissue integration. These results indicate that fabricated composite nanofiber scaffolds with multifunctional characteristics will have a highest potential as a future candidate for promoting new tissues artificially.

KEYWORDS
3D scaffolds, antibacterial properties, electrospinning nanofibers, tissue engineering, bone mineralization

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Review

Reconstructing nanofibers from natural polymers using surface functionalization approaches for applications in tissue engineering, drug delivery and biosensing devices

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ABSTRACT

Previously, the nanofibers were predominantly fabricated from synthetic polymers due to their excellent mechanical properties. Understanding the different complex processes in fabrication and various process parameters involved have not only allowed the use of natural polymers for fabricating nanofibers but also broadened the scope of applications. To date, many of the natural polymeric composites have been fabricated by different functionalization techniques to increase their applicability. Nanofibers fabricated from natural polymers have been chemically functionalized by a variety of molecules like drugs, enzymes, metal ions etc. by techniques such as plasma treatment, wet chemical method, graft polymerization and co-electrospinning of surface-active molecules. Furthermore, the nanofibers derived from natural polymers have been surface-coated on the synthetic polymers to induce extracellular matrix mirroring properties like cell adhesion, migration, proliferation and differentiation. In this review, we have not only investigated the various novel and facile functionalization approaches but potential properties and applications are discussed as well. The various surface chemistry modifications of the natural polymeric nanofibers and their potential applications in drug delivery, enzymology, catalysis, filtration, biosensing and tissue engineering are discussed. In addition, a brief presentation of an overview of challenges and future scope with the aim of making them a clinical success has been presented.

1. Introduction

Recently, nanofibers fabricated from synthetic and natural polymers have been surface-modified with different bioactive molecules, therapeutic agents etc. for biosensing, drug delivery, filtration and tissue engineering applications. On one hand, synthetic polymers offer the possibility of easily fabricating the nanofibers by different techniques like electrospinning, however, they lack biologically tunable properties [1,2]. Nanofibers fabricated using natural polymers have a unique feature of mimicking the biological niche, however, they are often not considered as gold standards because of the difficulty in processing techniques, instability and weak mechanical properties [3–5]. To overcome these limitations, surface chemistry provides a unique solution to modify these polymers in terms of mechanical as well as the biological properties [6]. These methods invoke modifying the surfaces of the natural polymers with different chemical moieties, bioactive molecules and/or inorganic ions [7–9]. Moreover, it can be achieved tactfully using surface immobilization of a natural polymer over the as-spun synthetic nanofibers [10,11]. Because synthetic polymers have excellent processing properties for electrospinning, therefore, a wide variety of natural polymers are immobilized onto the surface of the synthetic polymers without compromising its original topography [12,13]. Since tissue regeneration process involves the diverse biochemical signaling aspects, the cells contacting the biologically functionalized synthetic nanofibers result in the enhanced cell-specific phenotype and organization that makes the regenerative process trouble-free [14,15]. Besides, the biologically functionalized nanofibers have the absolute ability to direct enhanced cell-specific phenotypes and as such to organize tissue regeneration process [16].

Electrospinning has been considered as a versatile technique for the fabrication of nanofibers [17,18]. During the last few decades, this technique has been improvised to shelter various unique applications like drug delivery, biosensing and tissue engineering [19–23]. In the field of tissue engineering, electrospun mats have been incorporated with different biological cues [24] and/or stem cells [25] to induce them into osteogenic lineage. To enable sustained delivery of the drugs,

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Novel lavender oil and silver nanoparticles simultaneously loaded onto polyurethane nanofibers for wound-healing applications

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ABSTRACT

Synthetic polymers, especially those with biocompatible and biodegradable characteristics, may offer effective alternatives for the treatment of severe wounds and burn injuries. Ideally, the scaffold material should induce as little pain as possible, enable quick healing, and direct the growth of defect-free epidermal cells. The best material with this multifunctionality, such as self-healing dressings, should be hydrophilic and have uninterrupted and direct contact with the damaged tissue. In addition, the ideal biomaterial should have some antibacterial properties. In this study, a novel technique was used to fabricate composite electrospun wound-dressing nanofibers composed of polyurethane encasing lavender oil and silver (Ag) nanoparticles (NPs). After electrospinning, the fabricated nanofibers were identified using various techniques, including scanning electron microscopy (SEM) and transmission electron microscopy (TEM). An abundance of Ag NPs in the fibers decreased the diameter of the fibers while increased concentration of the lavender oil increased the diameter. Fourier transform infrared (FTIR) and X-ray diffraction (XRD) studies showed the presence of the lavender oil and Ag NPs in the fiber dressings. The Ag NPs and lavender oil improved the hydrophilicity of the nanofibers and ensured the proliferation of chicken embryo fibroblasts cultured *in-vitro* on these fiber dressings. The antibacterial efficiency of the nanofiber dressings was investigated using *E. coli* and *S. aureus*, which yielded zones of inhibition of 16.2 ± 0.8 and 5.9 ± 0.5 mm, respectively, indicating excellent bactericidal properties of the dressings. The composite nanofiber dressings have great potential to be used as multifunctional wound dressings; offering protection against external agents as well as promoting the regeneration of new tissue.

1. Introduction

Polymeric nanofibers hold enormous potential in the fields of wound healing (Abrigo et al., 2014), antibacterial dressings (Zahedi et al., 2010), biosensor devices (Matlock-Colangelo and Baeumner, 2012), filtration technology (Qin and Wang, 2006), optoelectronics (Wang et al., 2013), and drug delivery systems (Sofi et al., 2018; Yoo et al., 2009). Polymeric nanofibers are used in these fields because of their various properties such as high surface- area-to-volume ratio, sketched porosity, tailored fiber morphology, ability to encapsulate drug molecules, and the possibility of customization using various physicochemical functionalization approaches. With the advent of cutting-edge and high-throughput fabrication technology, polymeric fibers can be used in different fields, including protective clothing (Gorji et al., 2012), agricultural materials (Mercante et al., 2017), medical devices (Flanagan, 2009), filtration aids (Koslow, 2005), automobile industry (Sreekala et al., 2008), and hydrogen production (Bulushev et al., 2016). From a nanotechnology perspective, the main focus is the development of reliable, robust, and cost-effective nanofibers (Luo et al., 2012).

The fabrication of nanofibers using different polymers can be achieved through a variety of modern techniques. For example, electrospinning (Sheikh et al., 2015; Wani et al., 2017), centrifugal spinning (Zhang and Lu, 2014), pressurized gyration (Mahalingam and Edirisinghe, 2013), template synthesis (Che et al., 1998), phase separation (Ashraf et al., 2019), phase assembly (Bull et al., 2005), and

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Recent Progress in the Biological Basis of Remodeling Tissue Regeneration Using Nanofibers: Role of Mesenchymal Stem Cells and Biological Molecules

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Abstract

Opening up new and unlimited avenues in the biomedical field, tissue engineering and regenerative medicine, the electrospinning process is considered as a versatile and the most preferred technique for the fabrication of nanofibers. These tailor-designed nanofibers provide a desirable and bio-inspired physiological niche to cells for better attachment and subsequent proliferation. In this review, an attempt is made to explain the importance of various topological and morphological parameters of nanofibrous scaffolds for efficient bio-mimicking. Some novel approaches (*e.g.*, appropriate functionalization and extracellular matrix derived from decellularization) utilized for better mimicking and exponential growth of regenerating tissues are also discussed. Furthermore, this review highlights the important parameters necessary for the attachment, proliferation and differentiation of the mesenchymal stem cells for tissue regeneration. The importance of growth factors and their role after introducing the electrospinning techniques for efficient delivery and their role in the proliferation of mesenchymal stem cells in the different specific lineage (*e.g.*, tenogenic, chondrogenic, neurogenic and osteogenic differentiation) are discussed.

Keywords: electrospinning, nanofibers, bio-mimicking, stem cells, bioactive molecules, regenerative medicine

1 Introduction

Nanotechnology, owing its interdisciplinary nature intends to bring remarkable properties in materials used for a wide range of application[1]. Subsequently, diverse types of nanomaterials have been prepared for the application in regenerative medicine, biomedical and tissue engineering in addition to having industrial and commercial significance[2–5]. Among the wide range of the nanomaterials, the nanofibrous scaffolds have been intensively used in the various fields of tissue engineering[6,7]. Due to its high adaptability, electrospinning is one of the most commonly used techniques in nanofiber production[8,9]. This process is electrostatically driven in which polymeric solution under the influence of high voltage produces nanofibers[10]. Moreover, the various parameters controlling the process of electrospinning are easy to engineer, as per the experimental requirements, thus providing the versatility to this technique[11,12]. Therefore, the large number of polymers (both natural and synthetic) has been fabricated into the nanofibrous scaffolds, with the advent of this technique. Plethora of natural polymers such as polysaccharides (*e.g.*, alginates, chitosan and hyaluronic acid), polypeptides (*e.g.*, silk fibroin, gelatin and collagen)[15–17] and synthetic polymers (*e.g.*, poly(ε-caprolactone)[18,19], poly(ethylene oxide)[16], poly(vinyl alcohol)[20], polyurethane[21], poly(lactic-co-glycolic acid)[21,22] and poly(L-lactic acid)[23] have been fabricated and/or tailor-manipulated into functional scaffolds in progression towards regenerative medicine[24].

Advanced technologies indicate that regenerative medicine correlates with tissue engineering and regeneration potential of the stem cells as distinct strategies for tissue repair and healing process. This has recently paved a strong potential for advancement in scaffold designing, controlled release systems and tailormade biomolecules for regeneration of different terminally damaged tissues[25,26]. The differentiation potential of the mesenchymal stem cells into many distinct lineages along with the architecture and nano-topography of ultra-fine nanofibers has captured the notable attention

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Recent Trends in the Fabrication of Starch Nanofibers: Electrospinning and Non-electrospinning Routes and Their Applications in Biotechnology

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Abstract Electrospinning a versatile and the most preferred technique for the fabrication of nanofibers has revolutionized by opening unlimited avenues in biomedical fields. Presently, the simultaneous functionalization and/or post-modification of as-spun nanofibers with biomolecules has been explored, to serve the distinct goals in the aforementioned field. Starch is one of the most abundant biopolymers on the earth. Besides, being biocompatible and biodegradable in nature, it has unprecedented properties of gelatinization and retrogradation. Therefore, starch has been used in numerous ways for wide range of applications. Keeping these properties in consideration, the present article summarizes the recent expansion in the fabrication of the pristine/modified starch-based composite scaffolds by electrospinning along with their possible applications. Apart from electrospinning technique, this review will also provide the comprehensive information on various other techniques employed in the fabrication of the starch-based nanofibers. Furthermore, we conclude with the challenges to be overcome in the fabrication of nanofibers by the electrospinning technique and future prospects of starch-based fabricated scaffolds for exploration of its applications.

Keywords Electrospinning · Starch nanofibers · Tissue-engineering · Wound dressing · Drug delivery

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Review

Recent trends in peripheral nervous regeneration using 3D biomaterials

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ABSTRACT

Mesenchymal stem cells (MSCs) owing their multipotency are known as progenitors for the regeneration of adult tissues including that of neuronal tissue. The repair and/or regeneration of traumatic nerves is still a challenging task for neurosurgeons. It is also a well-established fact that the microenvironment plays a primary role in determining the fate of stem cells to a specific lineage. In recent years, with the advent of nanotechnology and its positive influence on designing and fabrication of various 3D biomaterials have progressed to a greater extent. The production of 3D biomaterials such as nanofibers, conduits and hydrogels are providing a suitable environment for mimicking physiological niche of stem cells. These 3D biomaterials in combination with MSCs have been successfully analyzed for their potential in the regeneration of degenerative neurological disorders. This review primarily highlights the combinatorial effect of multipotent MSCs seeded on various 3D polymeric scaffolds in repair and regeneration of nervous tissue. The elaboration of MSCs from distinct sources reported so far in literature are summarized to understand their role in regeneration processes. Furthermore, we accentuate the application of 3D biomaterials especially the nanofibers, polymeric conduits, hydrogels infiltrated with MSCs harvested from distinct sources in the field of peripheral nerve regeneration studies.

1. Introduction

The design and fabrication of biomaterials for stimulating natural tissue regeneration is the ultimate goal of tissue engineering and regenerative medicine. However, the complexity of various tissue in our body renders such artificial tissues with the poor intrinsic property of self-regeneration during the course of post-traumatic recovery. The nervous system of our body is one of the most complex physiological systems having neurons as a main functional unit for the whole system. Owing to its complexity, it possesses the least possibility of self-regeneration. With tremendous advances in regenerative medicine, the researchers are exploring the various approaches towards the designing of biomaterials with their possible roles in the treatment of neurodegenerative diseases (Lv et al., 2010; Tian et al., 2012; Yao et al., 2013). The next generation biomaterials for tissue regeneration will serve to function as artificial abode thus delivering stem cell regulatory signals to specifically, stimulate cellular responses at the molecular level that intrinsically mediates the regeneration of tissues (Lutolf et al., 2009; Mooney and Vandenburgh, 2008). The specific properties of biomaterials such as architecture, surface topographies and addition of bioactive molecules can regulate the stem cell fate at both *in-vitro* and *in-vivo* conditions (Engler et al., 2006; Saha et al., 2008; Wang et al., 2014). In this regard, the researchers have exploited the use of various polymers such as poly(lactic acid), poly(lactic-co-glycolic acid) including natural polymers such as chitosan, silk fibroin, alginate and collagen for the fabrication of 3D biomaterials (Bonino et al., 2012; Zhao et al., 2013). These polymers have been fabricated into various 3D biomaterials forms such as nanofibers, hydrogels and conduits for nerve regeneration (Dinis et al., 2015; Maclean et al., 2015; Sofi et al., 2018b). Recently, the extensive work is going in the field of regenerative medicine where the researchers have employed the mesenchymal stem cells (MSCs) by virtue of their multipotent differentiation capacity into distinctive tissue lineages. In this regard, the MSCs have been isolated from various tissue sources of both adult and embryonic origin for regenerative applications (Hass et al., 2011).

In recent years, culturing of these cells on 3D scaffolds have promised various courses of actions to explore in the near future towards the regeneration of various disorders including neurological degenerative disorders (Uccelli et al., 2013). It is noteworthy to mention that in a native physiological environment the cells are retained in a 3D niche which is important for adhesion, proliferation and differentiation of cells (Watt and Huck, 2013). This fact inspires the researchers to develop various techniques for the fabrication of 3D scaffolds to replicate the native niche for optimum growth of MSCs. Among techniques, the electrospinning technique has revolutionized the production of nanofibers from different classes of biodegradable polymers (Ashraf

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Hydrophilically Modified Poly(Vinylidene Fluoride) Nanofibers Incorporating Cellulose Acetate Fabricated by Colloidal Electrospinning for Future Tissue-Regeneration Applications

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A composite consisting of mechanically strong Poly(vinylidene fluoride) (PVDF) and biochemically favorable Cellulose acetate (CA) nanofibers can be considered as an excellent choice due to their excellent mechanical properties of PVDF and desirable biological properties of CA. However, preparing nanofibers of composites, involving CA requires the use of harsh acidic solutions and high temperatures, which can have serious consequences on a bio-aspect of CA. In this study, we have successfully prepared suitable solutions comprising of PVDF and CA in dimethylformamide. Subsequently, these solutions were directly ejected out as nanofibers during the process of electrospinning. The nanofibers synthesized were characterized for physicochemical properties by scanning electron microscopy, contact angle, Fourier transform infrared, thermogravimetric, and X-ray diffraction spectroscopy. The results revealed that CA can be easily introduced in PVDF nanofibers, using a single solvent (i.e., dimethylformamide). The introduced strategy can favorably preserve the inherent biological nature of CA. Moreover, the nanofibers prepared using this methodology was investigated for cell toxicity and cell attachment properties. These studies were carried to figure out the beneficial features shown by the CA to suppress inherent toxicity of PVDF nanofibers. The results of these studies proved that NIH 3T3 fibroblasts upon incubation in the presence of composite nanofibers containing CA can proliferate well when compared to pristine PVDF nanofibers. POLYM. COMPOS., 00:000–000, 2018. © 2018 Society of Plastics Engineers

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INTRODUCTION

Advanced technologies (e.g., melt-blowing, phase-separation, self-assembly, template-synthesis, and electrospinning technique) are well-suited for the fabrication of nanofibers [1–4]. However, associated technology and infrastructure cost, limits their viability in almost all the applications, to create smart materials. The nanofibers are mainly fabricated via three different techniques (e.g., phase-separation, self-assembly, and electrospinning) [1–5]. Among these aforementioned techniques, the nanofibers are popularly fabricated via electrospinning, while changing the parameters (e.g., applied voltage, needle size, tip-to-collector distance, and humidity) which allows controlling the final fiber morphology and its overall production [6, 7]. The easily tunable and relatively low-cost attributes of this technique also represent a highly facile route for the efficient production of nanofibers across a range of polymers and ceramics [8–10]. In this regard,

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RESEARCH ARTICLE

A facile route to synthesize β-Ga_2O_3 nanoparticles from γ-polymorph through a rapid microwave route and their optical properties

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Abstract

Due to the wide bandgap, monoclinic structure and thermodynamic stability, β-polymorph form of Ga_2O_3 nanomaterials is well-received for various applications. However, as the γ-Ga_2O_3 is difficult to synthesize, less attention has been paid towards it and its conversion to β-polymorph. This paper reports the single-step synthesis of γ-Ga_2O_3 using a microwave-assisted procedure. In this regard, γ-Ga_2O_3 powders are synthesized in minutes using benzyl alcohol as the solvent using gallium acetylacetone as the precursor. The XRD of the as-prepared powders indicates the formation of the γ-Ga_2O_3 phase, the very broad peaks indicative of the small crystallite size as confirmed by TEM. The γ-Ga_2O_3 powders were annealed at different temperatures and the complete phase conversion of γ-Ga_2O_3 phase to β-Ga_2O_3 phase happens at 700 °C. The TEM analysis shows the crystallite size to be $\approx$10 nm for the annealed β-Ga_2O_3 phase. The as-prepared nanopowders show very weak luminescence under excitation and in contrast, a blue-green emission is observed in case of annealed powders. This confirms the presented strategy as having the potential to use β-Ga_2O_3 nanopowders for different optoelectronic applications.

KEYWORDS
FTIR, Ga_2O_3, luminescence, microwave-synthesis, nanoparticles

1 | INTRODUCTION

New synthesis techniques that enable scientists to perform more experiments within a given time would be very beneficial to scientific community as well as the R&D enterprise. Microwave-assisted solution-based chemistry, which makes fast synthesis possible, is such a technique.[1,2] Microwave-assisted synthesis (MAS) of inorganic materials is considered a nascent technology which dramatically reduces reaction times due to the solvent superheating effect, improving reaction yields, avoiding byproducts and simplifying/shortening reaction procedures for combinatorial chemistry. Furthermore, MAS uses a safe heating source that can turned "on" and "off" instantaneously and can be applied in solvent-free environment. This often offers better product quality, sustainability and chemical yield, which is the advantageous compared to traditional heating sources.[3] Therefore, the MAS technique is expected to play an significant role in the environmentally friendly "synthetic nanotechnology" of the future.[1] Microwave-enhanced chemistry is based on the efficient heating of molecules by two main mechanisms: dipole rotation and ionic conduction which has been widely discussed by several authors.[1,3] The microwave technique greatly contributes to all areas of synthetic chemistry, particularly in the fabrication of nanostructures. The field of

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Green Synthesis of $Gd(OH)_3$ and $Eu:Gd(OH)_3$ Nanorods: Effect of Reaction Parameters on Morphology, Crystallinity and Thermal Conversion to Photoluminescent Oxide Nanorods

Abdul Hanan Khan, Saima Masood, Aaliya Majeed, Sadaf Nazir, Piyush Jaiswal, S. A. Shivashankar, and Shafquat Majeed

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Abstract

Through a green approach using water as a solvent, nanorods of $Gd(OH)_3$ in the diameter range of 15–50 nm and lengths varying from 40 nm to 290 nm were synthesized at low temperatures with high crystallinity. The as-prepared $Gd(OH)_3$ nanorods were characterized by various methods like XRD, TGA, TEM, etc. The effect of reaction time, base and surface directing agent on the crystallinity and morphology of $Gd(OH)_3$ powders were also investigated. Further, through a similar route Eu doped $Gd(OH)_3$ nanorods were also prepared (showing a similar morphology as undoped powders) that were annealed at modest temperatures to obtain $Eu:Gd_2O_3$ powders and their photoluminescence properties were analyzed.

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ARTICLE

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Design, synthesis, and anticancer evaluation of acetamide and hydrazine analogues of pyrimidine

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Abstract
A library of acetamide and hydrazine analogues were generated on the pyrimidine ring through a multistep reaction starting from 5-nitro-pyrimidine-4,6-diol and pyrimidine-4,6-diol, respectively. The synthesized analogues were screened for in vitro cytotoxic activity against various human cancer cell lines like HCT-1 and HT-15 (colon), MCF-7(breast), PC-3 (prostrate), SF268 (CNS) using MTT method. From the bioassay results, it was observed that even though many of the synthesized derivatives exhibited a good potency against various screened cancer cell lines, compound **14a** from the acetamide series was found to show potent anticancer activity on all the tested cancer cell lines with IC_{50} value of 0.36μM on CNS cell line and 1.6μM on HT-21 cell line, and compound **19xxi** from hydrazine series of pyrimidine showed potent activity against three tested cancer cell lines with IC_{50} value of 0.76μM on HT-29 cell line, 2.6μM on HCT-15, and 3.2μM on MCF-7 cell line.

1 | INTRODUCTION

With the continuous increase in mortality rate due to cancer, it has gradually become one of the most complicated diseases that threatens the human life and is responsible for an estimated 9.6 million deaths in 2018.[1] Globally, about one in six deaths is due to cancer. Although there are many effective therapeutic methods in clinical use for the control of cancer,[2] chemotherapy alone or in combination with surgery is commonly the most efficient method for the treatment of cancer. However, the use of currently available chemotherapeutic drugs is limited because of their toxic side effects and drug resistance.[3] Therefore, over the years, the main effort in the field of medicinal chemistry has been the identification of new chemical entities with special characteristics as effective anticancer molecules from both natural and synthetic sources. Out of diverse chemical entities with proven biological properties, nitrogen-containing heterocyclic compounds are of great importance as their structural subunits exist in many natural products such as vitamins, hormones, and antibiotics because of which they have engrossed significant attention in the field of medicinal chemistry.[4–6]

Heterocyclic compound pyrimidine occupies a significant position in the medicinal world because of its diverse biological properties. It has been identified as an important pharmacophore interacting with the synthesis and functions of nucleic acids.[7] Pyrimidine ring is the building component of DNA and RNA because derivatives of pyrimidine exhibit diverse pharmacological activities such as antiviral, antimalarial, antimicrobial, anti-inflammatory, and anticancer.[8–13] Among its diverse medicinal attributes, anticancer activity is most extensively reported. From the last few decades, several chemotherapeutic agents have been developed from the reprivatization of the

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MINI-REVIEW ARTICLE

A Review on Remdesivir: A Broad-spectrum Antiviral Molecule for Possible COVID-19 Treatment

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Abstract: Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), a novel coronavirus strain and the causative agent of COVID-19 was emerged in Wuhan, China, in December 2019 [1]. This pandemic situation and magnitude of suffering have led to global effort to find out effective measures for discovery of new specific drugs and vaccines to combat this deadly disease. In addition to many initiatives to develop vaccines for protective immunity against SARS-CoV-2, some of which are at various stages of clinical trials, researchers worldwide are currently using available conventional therapeutic drugs with the potential to combat the disease effectively in other viral infections and it is believed that these antiviral drugs could act as a promising immediate alternative. Remdesivir (RDV), a broad-spectrum anti-viral agent, initially developed for the treatment of Ebola virus (EBOV) and known to showed promising efficiency in *in vitro* and *in vivo* studies against SARS and MERS coronaviruses, is now being investigated against SARS-CoV-2. On May 1, 2020, The U.S. Food and Drug Administration (FDA) granted Emergency Use Authorization (EUA) for RDV to treat COVID-19 patients [2]. A number of multicentre clinical trials are on-going to check the safety and efficacy of RDV for the treatment of COVID-19. Results of published double blind, and placebo-controlled trial on RDV against SARS-CoV-2, showed that RDV administration led to faster clinical improvement in severe COVID-19 patients compared to placebo. This review highlights the available knowledge about RDV as a therapeutic drug for coronaviruses and its preclinical and clinical trials against COVID-19.

Keywords: Coronavirus, COVID-19, remdesivir, therapeutic molecules, drug re-purposing, therapeutics.

1. INTRODUCTION

Coronaviruses are a family of enveloped viruses characterized by club like spikes that project from their surfaces. The word Corona in Latin means halo or crown. These are single-stranded RNA genome that infects animal species and humans [3, 4]. The first coronavirus was identified in 1937 which was responsible for causing bronchitis in birds and identified to have the potential to cause devastating effect on poultry stock [5-7]. In humans, coronaviruses were later identified in 1960s from people with common cold [8-9]. Among globally identified Coronaviruses, various types of Coronaviruses that have been identified to cause infection in humans are 229E, NL03, OC43, HKU1. However, the notion about Coronaviruses changed with the discovery of two new strains of Coronavirus that caused the outbreak of SARS (Severe Acute Respiratory Syndrome) pandemic in 2003 and MERS (Middle Eastern Respiratory Syndrome) in 2012 with death rates greater than 10% and 35% respectively. Both these strains of Coronaviruses are believed to have emerged from native bat populations, and were transmitted through an intermediate host to humans [10-15].

In December 2019, a novel strain of Coronaviruses SARS-CoV-2 was reported to have emerged from Wuhan, China's Hubei Province belonging to the same family of viruses that caused SARS and MERS as well as the other 4 human Coronaviruses [16, 17]. Evidence supports that the novel Coronavirus SARS-CoV-2 also originated from bats [18]. The illness caused by SARS-CoV-2 was termed as COVID-19 by the WHO, the acronym derived from Coronavirus disease 2019. Since its outbreak, it has now spread to nearly whole world leading to infections in millions of people globally and leading to nearly half a million deaths. WHO responded officially by declaring COVID-19 as a global pandemic on March 11, 2020 [19, 20]. The cases of COVID-19 have been reported almost in all continents of the world. As of Jan 2021, over 83 million cases have been re-

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Clinical relevance of biomarkers, new therapeutic approaches, and role of post-translational modifications in the pathogenesis of Alzheimer's disease

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Alzheimer's disease (AD) is a neurodegenerative disorder that causes progressive loss of cognitive functions like thinking, memory, reasoning, behavioral abilities, and social skills thus affecting the ability of a person to perform normal daily functions independently. There is no definitive cure for this disease, and treatment options available for the management of the disease are not very effective as well. Based on histopathology, AD is characterized by the accumulation of insoluble deposits of amyloid beta (Aβ) plaques and neurofibrillary tangles (NFTs). Although several molecular events contribute to the formation of these insoluble deposits, the aberrant post-translational modifications (PTMs) of AD-related proteins (like APP, Aβ, tau, and BACE1) are also known to be involved in the onset and progression of this disease. However, early diagnosis of the disease as well as the development of effective therapeutic approaches is impeded by lack of proper clinical biomarkers. In this review, we summarized the current status and clinical relevance of biomarkers from cerebrospinal fluid (CSF), blood and

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Oral delivery of aescin-loaded gelatin nanoparticles ameliorates carbon tetrachloride-induced hepatotoxicity in Wistar rats

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ABSTRACT

Aim: The liver plays a crucial role in biotransformation but it is susceptible to chemical-induced damage, known as hepatotoxicity. Traditional therapies for protecting the liver face significant challenges, including poor bioavailability, off-target effects, adverse reactions, drug breakdown, and inadequate uptake. These issues emphasize the need for precise, targeted therapeutic approaches against hepatotoxicity.

Materials and methods: The objective of our research was to develop a customized, biocompatible, and biodegradable nanodrug delivery system for hepatoprotection. We chose collagen hydrolyzed protein, or gelatin, as the base material and utilized solvent evaporation and nanoprecipitation methods to create nanoparticles with size ranging from 130 to 155 nm. The resulting nanoparticles exhibited a spherical and smooth surface, as confirmed by scanning and transmission electron microscopy.

Key findings: Bioactive aescin (AES), into these gelatin nanoparticles (AES-loaded gel NPs), we tested these nanoparticles using a hepatotoxicity model. The results were indicating a significant reduction in the levels of key biomolecules, including NF-κB, iNOS, BAX, and COX-2 and decreased serum levels of enzymes ALT and AST. This reduction correlated with a notable alleviation in the severity of hepatotoxicity. Furthermore, the treatment with AES-loaded gel NPs resulted in the downregulation of several inflammatory and liver-specific biomarkers, including nitrite, MPO, TNF-α, and IL-6.

Significance: In summary, our study demonstrates that the AES-loaded gel NPs were markedly more effective in mitigating experimental hepatotoxicity when compared to the free aescin. The nanoparticles exhibited a propensity for suppressing liver damage, showcasing the potential of this targeted therapeutic approach for safeguarding the liver from harmful chemical insults.

1. Introduction

Liver is a vital organ. It involves crucially in the function of detoxification, digestion, and metabolism which are essential to survive, liver dysfunction can have major health risks and maybe even lead to mortality. Contrarily, idiosyncratic liver damage compared with drug-induced hepatotoxicity is not dose-dependent. IT regulated by the host (patient gender, age and immunological mechanisms comprising the mediators of the tumor necrosis factor family), the medication (lipophilicity, drug weight) and the habitat [1]. The assessment of the overall prevalence of hepatotoxicity is more challenging by resemblance in the symptomology of drug-induced hepatic injury and other abnormal

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REVIEW ARTICLE

Repurposing of Plant-based Antiviral Molecules for the Treatment of COVID-19

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Abstract: COVID-19, stemming from SARS-CoV-2, poses a formidable threat to global healthcare, with a staggering 77 million confirmed cases and 690,067 deaths recorded till December 24, 2023. Given the absence of specific drugs for this viral infection, the exploration of novel antiviral compounds becomes imperative. High-throughput technologies are actively engaged in drug discovery, and there is a parallel effort to repurpose plant-based molecules with established antiviral properties. In this context, the review meticulously delves into the potential of plant-based folk remedies and existing molecules. These substances have showcased substantial viral inhibition in diverse *in vivo*, *in silico*, and *in vitro* studies, particularly against critical viral protein targets, including SARS-CoV-2. The findings position these plant-based molecules as promising antiviral drug candidates for the swift advancement of treatments for COVID-19. It is noteworthy that the inherent attributes of these plant-based molecules, such as their natural origin, potency, safety, and cost-effectiveness, contribute to their appeal as lead candidates. The review advocates for further exploration through comprehensive *in vivo* studies conducted on animal models, emphasizing the potential of plant-based compounds to help in the ongoing quest to develop effective antivirals against COVID-19.

Keywords: Medicinal plants, Drug molecules, SARS-CoV-2, Plant-based antivirals, COVID-19, Middle Eastern Respiratory Syndrome (MERS).

1. INTRODUCTION

Viruses perpetually pose a threat to humanity, causing numerous worldwide diseases [1]. Coronaviruses, characterized by their enveloped, non-segmented, positive-single-strand RNA structure and crown-like spikes, belong to the family Coronaviridae, exhibiting a genome size of 27-32 Kb [2]. Among the seven identified human coronaviruses (HCoVs), strains like 229E, NL03, OC43, and HKU1 typically induce mild infections like the common cold [2]. However, severe outbreaks like the 2012 Middle Eastern Respiratory Syndrome (MERS) in Saudi Arabia and the 2003 Severe Acute Respiratory Syndrome (SARS) pandemic in China's Guandong province resulted in death rates exceeding 10% and 35%, respectively [3-7]. MERS-CoV and SARS-CoV, originating from native bat populations and spread through intermediate hosts, caused these deadly outbreaks [8-10]. In December 2019, a novel coronavirus strain, SARS-CoV-2, appeared in Wuhan, Hubei Province, that was termed as coronavirus disease 2019 (COVID-19)

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