Students Publications

INDEX

Sr. No.	Calendar Year	Number of Research Papers Published
1	2023	17
Total		**17**

H.R. Patel Institute of Pharmaceutical Education & Research Shirpur * OFFICE SEAL

Dr. S. B. Bari
Principal

PRINCIPAL
H.R Patel Institute of Pharmaceutical Education & Research
Shirpur Dist.Dhule(M.S.)

Student's publications in the Journals notified on UGC website during calendar year 2023-2024

Title of paper	Name of the author/s	Publication date	Name of journal	Calendar Year of Publication	ISSN number	Link to website of the Journal	Link to article / paper / abstract of the article	Scopus/ Web of Science/ UGC Care Link
Calendar Year 2023								
Design of polyacrylamide grafted sesbania gum-mediated pH-responsive IPN-based microbeads for delivery of diclofenac sodium: In-vitro-in-vivo characterizations	**P Devkar, SN Nangare**, LR Zawar, NR Shirsath, PS Bafna, PG Jain	27/01/23	International Journal of Biological Macromolecules	2023	0141-8130	https://www.sciencedirect.com/science/article/abs/pii/S0141813023002465?via%3Dihub	https://doi.org/10.1016/j.ijbiomac.2023.123360	https://www.scopus.com/sourceid/17544
Graphene Quantum Dots Incorporated UiO-66-NH2 Based Fluorescent Nanocomposite for Highly Sensitive Detection of Quercetin	**SN Nangare, S Patil, K Chaudhari,** ZG Khan, A Patil, PO Patil	01/03/23	Nano Biomedicine and Engineering	2023	2097-3837	https://www.sciopen.com/article/10.26599/NBE.2023.9290005	https://doi.org/10.26599/NBE.2023.9290005	https://www.scopus.com/sourceid/19900195033
Design, Development and Characterization of Ropinirole Mouth Dissolving Film by using Spin Coating Technique	B Akhade, VK Chatap, P Jain, MR Bhat	25/06/23	International Journal of Drug Delivery Technology	2023	2588-8943	https://ijddt.com/volume13issue2/	https://doi.org/10.25258/ijddt.13.2.10	https://www.scopus.com/sourceid/20500195212
Synthesis and Characterization of Hydroxypropyl Sesbania Galactamannan Seed Gum for Pharmaceutical Application	VK Chatap, G Choudhari, P Jain, MR Bhat	25/06/23	International Journal of Pharmaceutical Quality Assurance	2023	0975-9506	https://ijpqa.com/volume14issue2/	https://doi.org/10.25258/ijpqa.14.2.11	https://www.scopus.com/sourceid/21100204506

A comprehensive exploration of tartrazine detection in food products: Leveraging fluorescence nanomaterials and electrochemical sensors: Recent progress and future trends	**SS Chaudhari**, PO Patil, SB Bari, ZG Khan	09/09/23	Food Chemistry	2023	1873-7072	https://www.sciencedirect.com/science/article/abs/pii/S0308814623020435?via%3Dihub	https://doi.org/10.1016/j.foodchem.2023.137425	https://www.scopus.com/sourceid/24039
Preparation and Characterization of Pitavastatin Calcium Loaded Biodegradable Porous Starch as Carrier Platform for Drug Delivery	BK Marathe, GS Patil, V Dhangar, VK Chatap	15/01/23	International Journal of Pharmaceutical Sciences and Nanotechnology	2023	0974-3278	https://www.ijpsnonline.com/index.php/ijpsn/article/view/3767	https://doi.org/10.37285/ijpsn.2023.16.6.4	https://www.scopus.com/sourceid/21101050125
Custard apple peels containing saponin: isolation and formulation of herbal shampoo	**SN Nangare, DP Gosavi**, JR Pantwalawalkar and VK Chatap	15/09/23	Indian Drugs	2023	0019-462X	https://www.indiandrugsonline.org/issuesarticle-details?id=MTQ4Mw==	https://doi.org/10.53879/id.60.08.13219	https://www.scopus.com/sourceid/22375
Preparation of Crystallinity Tailored Silk Fibroin-Sodium Alginate Based Floating Microbeads for Nevirapine Delivery	**BD Patil, SN Nangare**, LR Zawar	01/07/23	Cellulose Chemistry and Technology	2023	2457-9459	https://www.cellulosechemtechnol.ro/pdf/CCT5-6(2023)/p.527-539.pdf	https://doi.org/10.35812/CelluloseChemTechnol.2023.57.47	https://www.scopus.com/sourceid/25811
Chitosan–Sesbania Gum Mediated pH-Responsive Polyelectrolyte Complexes for Targeted Delivery of Diclofenac Sodium: Preparation and Spectroscopical Evaluation	**V Chaudhari, S Tawade, SN Nangare, Ki Rajput**, NR Shirsath, PS Bafna, LR Zawar	01/07/23	Indian Journal of Pharmaceutical Education and Research	2023	0019-5464	https://pdfs.semanticscholar.org/1074/193cbabb5075b105d7cc33207534603190b.pdf	https://doi.org/10.5530/ijper.57.3s.65	https://www.scopus.com/sourceid/19200156909

Application of surface nitrogen-doped graphene quantum dots in the sensing of ferric ions and glutathione: Spectroscopic investigations and DFT calculations	**ZG Khan, TN Agrawal**, SB Bari, SN Nangare, PO Patil	03/11/23	Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy	2023	1873-2666	https://www.sciencedirect.com/science/article/abs/pii/S1386142523012933?via%3Dihub	https://doi.org/10.1016/j.saa.2023.123608	https://www.scopus.com/sourceid/24530
Poly-L-lysine functionalized graphene quantum dots embedded zirconium metal–organic framework-based fluorescence switch on-off-on nanoprobe for highly sensitive and selective detection of taurine	**SN Nangare, K Chaudhari**, PO Patil	14/09/23	Journal of Photochemistry and Photobiology A: Chemistry	2023	1010-6030	https://www.sciencedirect.com/science/article/abs/pii/S1010603023006238?via%3Dihub	https://doi.org/10.1016/j.jphotochem.2023.115158	https://www.scopus.com/sourceid/26966
One pot synthesis of cobalt and nitrogen co-doped graphene quantum dots based fluorescence 'On-Off-On' probe for dimethoate sensing: A proof of concept	**MR Mahajan**, PO Patil	10/11/23	Inorganic Chemistry Communications	2023	1387-7003	https://www.sciencedirect.com/science/article/abs/pii/S1387700323013308?via%3Dihub	https://doi.org/10.1016/j.inoche.2023.111718	https://www.scopus.com/sourceid/25267
Design of lactoferrin functionalized carboxymethyl dextran coated egg albumin nanoconjugate for targeted delivery of capsaicin: Spectroscopic and cytotoxicity studies	**H Rajput, SN Nangare**, ZG Khan, A Patil, SB Bari, PO Patil	27/11/23	International Journal of Biological Macromolecules	2023	0141-8130	https://linkinghub.elsevier.com/retrieve/pii/S0141813023052911	https://doi.org/10.1016/j.ijbiomac.2023.128392	https://www.scopus.com/sourceid/17544

Zinc metal-organic frameworks- graphene quantum dots nanocomposite mediated highly sensitive and selective fluorescence "On-Off-On" probe for sensing of quercetin	**SN Nangare, P Sangale**, A Patil, PO Patil	29/11/23	Acta Chimica Slovenica	2023	3812-4653	https://acsi-journal.eu/index.php/ACSi/article/view/7870	https://doi.org/10.17344/acsi.2022.7870	https://www.scopus.com/sourceid/22658
Nanosize design of carbon dots, graphene quantum dots, and metal–organic frameworks based sensors for detection of chlorpyrifos in food and water: A review	**MR Mahajan, SN Nangare**, PO Patil	07/07/23	Microchemical Journal	2023	0026-265X	https://www.sciencedirect.com/science/article/abs/pii/S0026265X23006756?via%3Dihub	https://doi.org/10.1016/j.microc.2023.109056	https://www.scopus.com/sourceid/20922
Preparation of pirfenidone loaded chitosan-polyvinyl alcohol-graphene oxide-based scaffold: Spectroscopical characterizations and antibacterial activity	**DD Borhade, SN Nangare**, DA Patil, PO Patil, GS Patil, GB Patil	01/03/23	Journal of Drug Delivery Science and Technology	2023	1773-2247	https://www.sciencedirect.com/science/article/abs/pii/S1773224723001776?via%3Dihub	https://doi.org/10.1016/j.jddst.2023.104325	https://www.scopus.com/sourceid/22204
Artificial Intelligence in the Paradigm Shift of Pharmaceutical Sciences: A Review	RS Tade, SN Jain, **JT Satyavijay, PN Shah, TD Bari, TM Patil, RP Shah**	08/12/23	Nano Biomedicine and Engineering	2023	2150-5578	https://www.sciopen.com/article/10.26599/NBE.2023.9290043	https://doi.org/10.26599/NBE.2023.9290043	https://www.scopus.com/sourceid/19900195033

Dr. S. B. Bari
Principal

PRINCIPAL
H.R Patel Institute of Pharmaceutical Education & Research
Shirpur Dist.Dhule(M.S.)

International Journal of Biological Macromolecules 230 (2023) 123360

Contents lists available at ScienceDirect

International Journal of Biological Macromolecules

journal homepage: www.elsevier.com/locate/ijbiomac

Design of polyacrylamide grafted sesbania gum-mediated pH-responsive IPN-based microbeads for delivery of diclofenac sodium: *In-vitro-in-vivo* characterizations

Pratiksha Devkar [a,1], Sopan Nangare [a,1], Laxmikant Zawar [a,*], Nitin Shirsath [a], Piyush Bafna [b], Pankaj Jain [c]

[a] Department of Pharmaceutics, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur 425405, Maharashtra state, India
[b] Department of Pharmacology, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur 425405, Maharashtra state, India
[c] Department of Pharmacology, R. C. Patel Institute of Pharmaceutical Education and Research, Shirpur 425405, Maharashtra state, India

ARTICLE INFO

Keywords:
Sesbania gum
Acrylamide grafting
Interpenetrating polymer network
pH-sensitive microbeads, diclofenac sodium

ABSTRACT

Microwave-assisted grafting of polyacrylamide on sesbania gum (PAAM-g-SG) was implemented employing a 3^2 full factorial experimental design and was hydrolyzed using sodium hydroxide (NaOH) to form H-PAAM-g-SG. Further, the diclofenac sodium-loaded novel pH-sensitive interpenetrating polymeric network (IPN) microbeads were designed using an optimized H-PAAM-g-SG and sodium alginate (SA). Different spectroscopic analysis including FTIR spectroscopy, ^{1}H NMR spectroscopy, elemental analysis, thermal analysis, *etc.* was performed to confirm the synthesis of PAAM-g-SG and diclofenac-loaded pH-sensitive IPN H-PAAM-g-SG-SA microbeads. Here, Ca^{+2} ions combine with two strands of SA and form a round-shape structure that encloses uncross-linked H-PAAM-g-SG polymer and diclofenac sodium. As well, glutaraldehyde (GL) addition improved the mechanical strength due to acetal structure between hydroxyl of H-PAAM-g-SG and aldehyde of GL. The drug entrapment was confirmed proportional relationship to the Ca^{+2} ions concentration whereas an increase in GL concentration resulted in a reduced drug entrapment. The pH pulsatile study assured the reversible swelling-shrinkage behavior of IPN microbeads due to the carboxyl group of PAAM-g-SG. The drug release from H-PAAM-g-SG-SA microbeads (batch: S9) was found to be 84.21 % (12*h*) which was non-significant ($p > 0.05$; f2 = 79 ~ 90) over marketed formulation (83.31 %). Moreover, it follows the Korsmeyer Peppas ($R^2 = 0.996$) as the best-fit release kinetic model. The pH-sensitive release of diclofenac sodium from IPN H-PAAM-g-SG-SA microbeads was assured based on *in vivo* anti-inflammatory activity ($p < 0.05$). Therefore, developed novel pH-sensitive IPN microbeads based on H-PAAM-g-SG are a promising polymeric carrier substitute for delivery of drugs actuated by a pH stimulus.

1. Introduction

Sesbania gum is a natural polysaccharide obtained from the annual legume seeds (biological source: *Sesbania grandiflora*; family: Leguminosae). Importantly, it contains a synthetic framework similar to guar gum. The constituent of SG is α (1–6) glycosidic bond to galactose as well as β (1–4) glycosidic bond to mannose. Hence, it is composed of mannose and galactose with a proportion of 2:1. In pharmaceutical dosage form, it has been reported as a thickening agent, floating agent, cosmetics, *etc.* [1,2]. Literature reported that SG can be a suitable alternative for the development of advanced pharmaceutical dosage forms [3,4] such as hydrogels, beads, *etc.* It ensured that limited consideration was given to the utilization of SG as a potential replacement for excipients in pharmaceutical applications. Regardless of these benefits, there are issues with natural polysaccharides like uncontrolled hydration, lower shelf life, pH-dependent solubility, change in viscosity during storage, and terrific swellability. For the development of pharmaceutical dosage, there is a design to overcome the demerits of natural polysaccharides [5]. A wide variety of chemically modified/grafted polysaccharides has become an essential element in various biomedical applications [6].

* Corresponding author at: Department of pharmaceutics, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur 425405, Maharashtra state, India.
E-mail address: shwet.zawar@gmail.com (L. Zawar).
[1] These are the authors who contributed equally as the first author

https://doi.org/10.1016/j.ijbiomac.2023.123360
Received 7 October 2022; Received in revised form 29 December 2022; Accepted 17 January 2023
Available online 27 January 2023

Research Article

Nano Biomed Eng

Graphene Quantum Dots Incorporated UiO-66-NH_2 Based Fluorescent Nanocomposite for Highly Sensitive Detection of Quercetin

Sopan Nangare[1], Sayali Patil[1], Kalyani Chaudhari[1], Zamir Khan[1], Ashwini Patil[2], Pravin Patil[1]

[1] Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur, India
[2] Department of Microbiology, R. C. Patel Arts, Science and Commerce College, Shirpur, India

Corresponding author. E-mail: rxpatilpravin@yahoo.co.in

Received: Dec. 8, 2022; **Revised:** Jan. 30, 2023; **Accepted:** Feb. 19, 2023

Citation: S. Nangare, S. Patil, K. Chaudhari, et al. Graphene quantum dots incorporated UiO-66-NH_2 based fluorescent nanocomposite for highly sensitive detection of quercetin. *Nano Biomedicine and Engineering*, 2023.

http://doi.org/10.26599/NBE.2023.9290005

Abstract

Quercetin can help with a variety of health problems. Most methods for measuring quercetin in biological fluids are characterized by low sensitivity and selectivity. The employment of metal–organic frameworks in sensor applications with carbon-based materials ushers in a new era. In this study, blue fluorescent graphene quantum dots (GQDs) embedded in a UiO-66-NH_2 metal–organic framework-based nanoprobe (GQDs@UiO-66-NH_2) were constructed for quercetin sensing. Initially, maize husk was used to produce blue fluorescent GQDs, whereas zirconium tetrachloride and 2-aminoterephthalic acid were used to synthesize extremely luminous UiO-66-NH_2. The addition of quercetin to GQDs@UiO-66-NH_2 leads to fluorescence dampening due to the adsorption potential of UiO-66-NH_2. The complexation of zirconium ions with the 3-OH and 4-C=O functionalities of quercetin resulted in fluorescence quenching. The sensor has a linear concentration range and limit of detection for quercetin of 50–500 and 2.82 ng/mL, respectively. The nanoprobe's usefulness for quercetin detection was then validated by a selectivity investigation in the presence of interfering chemicals. Furthermore, the percentage relative standard deviations were 4.20% and 2.90%, respectively, indicating great stability and repeatability. Fluorescence "Turn-On–Off" nanoprobes provide a simple, quick, sensitive, and selective method for monitoring quercetin.

Keywords: quercetin; graphene quantum dots (GQDs); fluorescence; nanoprobe; metal–organic framework; GQDs@UiO-66 NH_2; sensitivity

Introduction

Quercetin is the most important flavonoid in fruits and vegetables [1]. It does not produce in human bodies [2]. Quercetin is widely reported for antioxidant, antiviral, immunomodulation, antitumor [3], and anti-inflammatory [4] applications. The literature claimed that 945 mg/m² is the safe dose for quercetin. A high dose of quercetin can produce different several health issues including hypertension, a decline in potassium levels in serum, and emesis [2]. Therefore, accurate measurement of the concentration of quercetin is essential in the biomedical field [3]. Moreover, to measure the bioavailability of quercetin, it is essential for pharmacological response [1]. In general, analysis of quercetin with a simplistic, speedy, highly selective, and sensitive method is a prime necessity [4].

RESEARCH ARTICLE

Design, Development and Characterization of Ropinirole Mouth Dissolving Film by using Spin Coating Technique

Bhavana Akhade[1], Vivekanand Chatap[1*], Prashant Jain[2], Mahesh Bhat[2]

[1]*Department of Pharmaceutics, H.R. Institute of Pharmaceutical Education and Research, Dhule, Maharashtra, India.*
[2]*Nuper Therapeutics, A division of Jain Pharmaceuticals, Pune, Maharashtra India.*

Received: 18th January, 2023; Revised: 20th May, 2023; Accepted: 24th May, 2023; Available Online: 25th June, 2023

ABSTRACT

The aim of the research was to develop a ropinirole mouth-dissolving film employing solvent casting and spin coating methods with sesbenia gum acting as a film-forming agent. Parkinson's disease is treated with ropinirole. Sesbenia gum was designed as a film-forming ingredient in the 25 to 600 mg concentration range for solvent casting and 50 to 250 mg for spin coating. For both procedures, the concentration of the plasticizer propylene glycol was optimized between (0.3 and 1.0 mL). Film-forming agent and plasticizer effects at various concentrations were examined. For the solvent casting and spin coating processes, the plasticizer concentration was 0.3 mL for each, while the optimal film-forming agent concentrations were 50 and 150 mg, respectively. Ropinirole MDFs were made employing an enhanced concentration and more excipients. In comparison to the solvent casting approach, the spin coating process produced films with better surface morphology, a 24 seconds shorter disintegration time, good tensile strength of 3.2 (N/mm^2), a thinner thickness of 0.2 mm, and a maximum drug content of 93.14%. Sesbenia gum has been discovered to have greater potential for the spin-coating method of developing a ropinirole mouth-dissolving film.

Keywords: Sesbenia gum, Ropinirole, Mouth dissolving film, Solvent casting and spin coating method.

International Journal of Drug Delivery Technology (2023); DOI: 10.25258/ijddt.13.2.10

How to cite this article: Akhade B, Chatap V, Jain P, Bhat M. Design, Development and Characterization of Ropinirole Mouth Dissolving Film by using Spin Coating Technique. International Journal of Drug Delivery Technology. 2023;13(2):516-521.

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

For most therapeutic agents, administration through the mouth has been considered the most convenient and well-liked delivery method. Over the past few decades, researchers have been working on developing intraoral delivery systems (IODS) that can provide the ideal drug exposure for the optimum therapeutic benefit. In order to provide those who had trouble in swallowing tablets, capsules and syrup, with an alternative to these traditional solid dosage forms, in the late 1970s, the first fast-dissolving drug delivery system was developed. The problem of swallowing solid dosage forms can be resolved with new and innovative oral drug delivery system, which swiftly dissolves in the mouth in a few seconds without water. Tablets, granules, pills, caplets, films, wafers and powders are part of fast and quick dissolving system. The tongue's top or bottom is where the film is placed. It maintains the application site while rapidly releasing the active ingredient for local and/or systemic absorption.[1]

A novel oral fast-dissolving dose form combines the convenience of dosing without water or beverage with the simplicity of administration. Despite their quick disintegration/ dissolution times, some patient groups still worry about swallowing solid pills and run the danger of choking. Fast-dissolving film eliminated The possibility of choking.[2] Oral films can be divided into the following three categories.[3]

- Mucoadhesive sustained release wafers,
- Mucoadhesive melt away wafers and
- Flash release

Fast-dissolving film criteria: A good oral film should melt or disintegrate in mouth in few seconds without being swallowed, and it should work effectively for flavor masking. There should be no little residue left in the mouth on oral intake. Environmental variables, including humidity and temperature, have minimal effects on oral fast-dissolving film.

Ropinirole is used to treat Parkinson's disease and the symptoms of restless legs syndrome. The production of oral films involves the rolling method, hot melt extrusion, solid dispersion, semisolid casting, and solvent casting. The current investigation used spin coating and solvent casting to produce the oral film for the drug ropinirole.[3]

*Author for Correspondence: vchatap@gmail.com

RESEARCH ARTICLE

Synthesis and Characterization of Hydroxypropyl *Sesbania* Galactamannan Seed Gum for Pharmaceutical Application

Vivekanand Chatap[1*], Ganesh Choudhari[1], Prashant Jain[2], Mahesh R. Bhat[2]

[1]*Department of Pharmaceutics, H.R. Institute of Pharmaceutical Education and Research, Shirpur, Maharashtra, India*
[2]*Nuper Therapeutics, A division of Jain Pharmaceuticals, Pune, Maharashtra, India.*

Received: 12th January, 2023; Revised: 19th March, 2023; Accepted: 20th May, 2023; Available Online: 25th June, 2023

ABSTRACT

The core focus of current research is chemical polysaccharide modification in pharmaceutical applications. The gum is made from the endosperm of *Sesbania grandiflora* Plant seeds that belongs to family Leguminosae. Both water-soluble and water-insoluble gum were present in the *Sesbania* seed powder; the water-soluble gum was removed during purification, yielding a 30% purification yield. In order to increase the applications of partially hydroxypropyl *Sesbania* gum, the modifications indicated here entail adding hydroxypropyl groups to the molecule under a variety of different conditions. Among the factors that were looked at were the etherifying agent concentration, alkaline volume, and preparation medium parameters, including the reaction time and temperature. The degree of substitution (DS) was raised, which boosted the unaltered gum's solubility, stability, and viscosity. Increases in an etherifying agent and alkali concentration, volume, reaction duration, and temperature increase DS from 0.4 to 0.7. The finished product was characterized using IR spectroscopy, differential scanning calorimetry, X-ray diffraction, scanning electron microscopy, rheologic property, solubility, swelling index, and gel fraction analysis of batch F1 as an improved batch. The alternate method for developing drug-loaded nanoparticles for controlled release dosages form by suing hydroxypropyl *Sesbania* gum.

Keywords: *Sesbania* gum, Hydroxypropylation, Chemical modification, Degree of substitution, Viscosity, Solubility.

International Journal of Pharmaceutical Quality Assurance (2023); DOI: 10.25258/ijpqa.14.2.11

How to cite this article: Chatap V, Choudhari G, Jain P, Bhat MR. Synthesis and Characterization of Hydroxypropyl *Sesbania* Galactamannan Seed Gum for Pharmaceutical Application. International Journal of Pharmaceutical Quality Assurance. 2023;14(2):303-309.

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Polysaccharide gums are among the most popular industry components and have become the subject of much research regarding their long-term sustainability, biodegradability and biological safety.[1] A few drawbacks, however accompany the use of gums. They include the potential of microbial contamination, changing rates of hydration, influenced by pH soluble content, thickening up, and viscosity loss on storage are a few of these. Gums can be chemically altered to reduce these limitations while simultaneously increasing their solubility and viscosity.[2]

According to Duke *et al.*, the endosperm, or outermost layer, of a seed of the species *Sesbania grandiflora* (Leguminosae) is used to make *Sesbania* gum. According to Faroogi *et al.*, *Sesbania* seeds are composed of a coat 6.9 to 18.9%, endosperm 40 to 42% and germ about 51.1%.

The outermost layer of seed is made up of galactose side chain residues linked by -(1-6) and a mannan backbone connected by -(1-4) glycosidic connections, which is known as galactomannan. According to one study, the ratio of galactose to mannose produced by the acid hydrolysis of *Sesbania* galactamannan gum was 1.2:2.2 as opposed to 1:3.9 for locust bean (carob), and for tara gum 1:2, and 1:3. It is believed that the varying degrees of branching are what produce the variances in the characteristics of galactamannan gums. More side groups reduce the amount of molecular bonding and improve the cold-water dispersion of gum, as reported as.[3,4]

Galactamannan, sometimes referred to as galactose side chain residues and a mannan backbone coupled by -(1-4) glycosidic linkages, make up the endosperm. In contrast to the ratios of 1:3.9 for locust bean (carob), 1:2, and 1:3 for Tara gum, one study found that the ratio of galactose to mannose generated by the acid hydrolysis of *Sesbania* galactamannan gum was 1.2:2.2. The differences in properties of galactamannan gums are assumed to be caused by the varied degree of branching.[5]

The reagents utilized and the reaction conditions have a significant impact on how effective the hydroxy propylation reaction is. Due to its accessible structure, the amorphous area

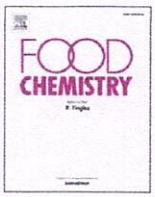
*Author for Correspondence: vchatap@gmail.com

Food Chemistry 433 (2024) 137425

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem



Review

A comprehensive exploration of tartrazine detection in food products: Leveraging fluorescence nanomaterials and electrochemical sensors: Recent progress and future trends

Sharayu S. Chaudhari [a], Pravin O. Patil [b], Sanjaykumar B. Bari [b], Zamir G. Khan [b,*]

[a] Department of Quality Assurance, H. R. Patel Institute of Pharmaceutical Education and Research Shirpur, Dist. Dhule, Maharashtra 425 405, India
[b] Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research Shirpur, Dist. Dhule, Maharashtra 425 405, India

ARTICLE INFO

Keywords:
Fluorescence nanomaterial
Carbon dot
Tartrazine
Quenching
Sensing
Food safety

ABSTRACT

Azo dyes are widely used as food coloring agents because of their affordability and stability. Examples include brilliant blue, carmoisine, sunset yellow, allura red, and tartrazine (Tar), etc. Notably, Tar is often utilized in hazardous food goods. They are frequently flavoured and combined with food items, raising the likelihood and danger of exposure. Therefore, detecting Tar in food is crucial to prevent health risks. Fluorescence nanomaterials and electrochemical sensors, known for their high sensitivity, affordability, simplicity, and speed, have been widely adopted by researchers for Tar detection. This comprehensive paper delves into the detection of Tar in food products. It extensively covers the utilization of advanced carbon-based nanomaterials, including CDs, doped CDs, and functionalized CDs, for sensitive Tar detection. Additionally, the paper explores the application of electrochemical sensors. The paper concludes by addressing current challenges and prospects, emphasizing efforts to enhance sensitivity, and selectivity for improved food safety.

1. Introduction

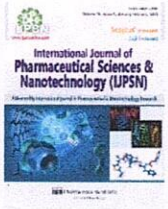
Tartrazine (Tar) (E 102) is an artificial orange-colored powdered azo dye (S. Chen, Yu, & Wang, 2018). This pigment was initially found in 1884 (Scientific Opinion on the Re-evaluation Tartrazine, 2009). This water-soluble azo food pigment has high stability, vivid color, high color strength, and low cost (Vidotti, Costa, & Oliveira, 2006). It is frequently found in food products, drugs, cosmetics, and pharmaceuticals (Tanaka, 2006). Tar is commonly used in a variety of foods, including soft drinks, sweets, juices, jellies, jams, flavor-infused chips, cakes, ice cream, and cereals (Demirkol, Zhang, & Ercal, 2012; Dey & Nagababu, 2022) and dairy products (Gan, Sun, Cao, Gao, Zhang, & Yang, 2012; State, van Staden, State, & Papa, 2022) to give them a yellow tint for easy identification, it is used in so many pharmaceutical products, including antacids, vitamins, prescription drugs (Mehmandoust, Erk, Karaman, Karimi, Bijad, & Karaman, 2021), and cold medications (Amin, Hameid II, & Abd Elsttar, 2010). However, Tar may have harmful health consequences such as altered hepatic and renal parameters, reproductive toxicity (Monisha, Sridharan, Kumar, Rangasamy, Krishnaswamy, & Subhashree, 2022), neuro-behavioral poisoning (Amin et al., 2010; Tanaka, 2006), eczema, allergic migraines (Jafari-Arvari, Saei-Dehkordi, & Farhadian, 2021), anxiety, oxidative stress (Dorraji & Jalali, 2017; Sakthivel, Sivakumar, Chen,& Pandi, 2018), and DNA damage (Mazlan, Lee, & Hanifah, 2017; Visweswaran, 2012) especially when it is ingested in excess quantity. The maximum level of Tar that has been approved for use with various food items falls was set at 7.5 mg/kg body weight per day and within the range of 50–500 mg/kg by the World Health Organization and European Parliament and Council Directive 94/36/EC respectively (Tanaka (2006)). Therefore, the detection of Tar in food products has become a pressing concern, sparking significant interest among researchers in recent times. Over the years, various widespread techniques like high-performance liquid chromatography (de Matos et al., 2021), enzyme-linked immune-sorbent assay (L. Xu, Yang, Dias, & Zhang, 2022), and capillary electrophoresis (Wang, Mu, Hu, Zhuang, & Ni, 2019) etc are frequently used to measure Tar. Nevertheless, these methods are time-consuming processes, expensive tools, pricey reagents, or hostile environmental practises, which will restrict their usefulness. Thus, it is becoming more

Abbreviations: QD, Quantum Dot; CDs, carbon Dots; Tar, Tartrazine; IFE, Inner Filter Effect; LOD, Limit of Detection; LOQ, Limit of Qualification; ADHD, Attention-Deficit/Hyperactivity Disorder.

* Corresponding author.
E-mail address: khanzamir.5588@gmail.com (Z.G. Khan).

https://doi.org/10.1016/j.foodchem.2023.137425
Received 15 May 2023; Received in revised form 29 August 2023; Accepted 4 September 2023
Available online 9 September 2023

International Journal of
Pharmaceutical Sciences and Nanotechnology (IJPSN)
http://www.ijpsnonline.com



RESEARCH ARTICLE

Preparation and Characterization of Pitavastatin Calcium Loaded Biodegradable Porous Starch as Carrier Platform for Drug Delivery

Bhushan K. Marathe | Gaurav S. Patil | Vijay Dhangar | Vivekanand K.Chatap*

Department of Pharmaceutics, H. R. Patel Institute of Pharmaceutical Education andResearch, Karwand Naka, Shirpur; Dist- Dhule (MS), India, 425405

***Correspondence author:** *Dr. Vivekanand K. Chatap, Associate Professor, Department of Pharmaceutics H. R. Patel Institute of Pharmaceutical Education and Research, Karwand Naka, Shirpur, Dist-Dhule (MS), India 425405.
E-mail: chatap@rediffmail.com

How to cite this article: Marathe Bhushan K., Patil Gaurav S., Dhangar Vijay and Chatap Vivekanand K., Preparation and Characterization of Pitavastatin Calcium Loaded Biodegradable Porous Starch as Carrier Platform for Drug Delivery, International Journal of Pharmaceutical Sciences and Nanotechnology. 2023, 16(6): 7049-7056.

MSID: 3767

https://doi.org/10.37285/ijpsn.2023.16.6.4

ABSTRACT

Introduction: Poor solubility and low oral bioavailability are major obstacles to the development of efficient drug delivery approaches. Numerous chemical entities fall into the biopharmaceutics classification system II (BCS II) class, categorized by low solubility and high permeability. Consequently, finding alternative solutions for improving drug efficacy becomes crucial. Hence, this study aims to formulate biodegradable porous acetostarch (BPSa) and biodegradable porous ethostarch (BPSe) carriers to augment the solubility profile of the poorly soluble drug candidate pitavastatin calcium (PTC).

Method: The biodegradable carriers (BPSa and BPSe) were prepared using the solvent exchange method. Then the PTC was loaded into the prepared carriers (PTC@BPSa and PTC@BPSe) using the passive drug loading procedure. Moreover, the obtained drug-carrier conjugates were evaluated using physiochemical evaluation techniques such as Fourier transform infrared spectroscopy (FTIR), x-ray powder diffraction (XRPD), and differential scanning calorimetry (DSC). Additionally, the surface morphology and drug release characteristics are determined.

Result: The experimental findings exhibited high drug content with 75.45% and 71.81% for PTC@BPSa and PTC@BPSe, respectively. The SEM analysis of the prepared conjugates demonstrates asymmetrical morphology with cracks between particles, indicating porous nature of the carriers. As a result of this, PTC@BPSa and PTC@BPSe exhibited modified drug release patterns, with cumulative releases of 78.63% and 78.50%, respectively.

Conclusion: The biodegradable porous carriers (BPSa and BPSe) effectively improve the dissolution pattern of PTC, by addressing the challenges associated with poor solubility. This study offers valuable insights into the potential of these biodegradable porous carriers as effective drug delivery platforms for increasing the efficacy of limited soluble medications.

Keywords:
Poorly solubility, Biodegradable porous starch, Carrier, Solvent exchange method, Pitavastatin calcium.

SHORT COMMUNICATION

CUSTARD APPLE PEELS CONTAINING SAPONIN: ISOLATION AND FORMULATION OF HERBAL SHAMPOO

ABSTRACT

Presently, the cosmetics sector is among the fastest-expanding sectors of the economy. Plenty of researchers have reported that natural surfactants could prominently replace synthetic surfactants considering the superiority in safety and effectiveness. This research aimed to isolate surfactants from custard apple peel and formulate an herbal shampoo. Initially, isolation of the saponin was accomplished followed by the formulation of herbal shampoo. Interestingly, optimized batch A demonstrated the optimum synthetic pH and high foaming capacity of shampoo for upto 4 mins. Moreover, herbal shampoo showed good cleansing properties and detergency. Additionally, it exhibited superior smoothing, no skin irritation, and a shining effect with the respect to the marketed formulation. Hence, it can be prominently used as a substitute for chemical surfactants in designing shampoo and other cosmetics.

Keywords: Herbal shampoo, saponin, natural surfactant, foaming ability

INTRODUCTION

Out of the plenty of cosmetics products, shampoo is a widely used cosmetic intended for hair applications including cleaning, shining and smoothing[1]. One of its principal components is the surfactant, which is incorporated in an appropriate concentration and form. A naturally obtained surfactant has low toxicity to humans. Moreover, they are biodegradable and biocompatible. It demonstrates excellent stability at different temperatures[2]. Reportedly, saponin demonstrates the ability to absorb excess sebum without any adverse reactions. Moreover, it also acts as an antifungal and antibacterial, which are important pro-perties in cosmetic formulation[3]. *Annona squamosal* belongs to the Annonaceae family[4]. Recently published literature divulged that the agro-waste *A. squamosal* fruit peel extract contains a higher concentration of saponin[5] that can be used as a substitute in the formulation of herbal shampoo. Hence, the main goal of the present research was to isolate saponin from custard apple (sitaphal) peel and to prepare herbal hair shampoo that can replace the chemical surfactant.

Formulation and evaluation of the herbal shampoo

At first, the cleaned custard apple fruit peels were converted into powder by grinding. After this, 100 g of powdered peels were defatted at 60 °C for 6 h using petroleum ether (solvent). Afterward, methanol was used to extract the saponin from defatted dried plant powder at 60 °C for 6 h yielding, a dark brown colored crude extract. Subsequently, the methanolic extract was dissolved in 50 mL of double distilled water (decanted three times with *n*-butanol). In this process, diethyl ether was used to precipitate the total saponin present inside the butanolic extract followed by filtration using a Whatman filter paper (Fig. 1A). Based on initial trials, the 3 different concentrations (0.5 g, 1 g, and 1.5 g) of isolated saponin were selected for the preparation of herbal shampoo. Simultaneously, an aqueous system was prepared using a mixture of double-distilled water (upto 100 mL), vitamin E oil (5 mL), glycerin (10 mL), *Aloe vera* juice (15 mL), and lemon juice (5 mL). Herein, *A. vera* juice acts as a conditioning agent whereas lemon juice was selected as a preservative. After that, these selected concentrations were added into 70 mL of aqueous solution in three separate beakers followed by continuous stirring in a water bath at 50 °C. Finally, the volume of the formulation was adjusted using double distilled water[6]. Several evaluation parameters were performed such as dry residue, dirt dispersion, moisture content, wetting time, foam stability, foaming ability, surface tension, detergency tests, *in vitro* skin irritation test[7] and stability study.

RESULTS AND DISCUSSION

Fourier Transform Infrared (FTIR) spectra of saponin (Fig. 1B) showed hydroxyl stretching vibration (3100-3500 cm^{-1}), carbonyl stretching vibration (1606 cm^{-1}), antisymmetric deformation peak of -CH- (1444.73 cm^{-1}), bending vibration peak within the C-O-H plane (284.63 cm^{-1}) and C-O-C stretching vibration (1110.23 cm^{-1}). Importantly, the color of shampoo varies with the

PREPARATION OF CRYSTALLINITY TAILORED SILK FIBROIN-SODIUM ALGINATE BASED FLOATING MICROBEADS FOR NEVIRAPINE DELIVERY

BHUPESH DIGAMBAR PATIL[#], SOPAN NAMDEV NANGARE[#] and LAXMIKANT RAMVALLABH ZAWAR[*]

Department of Pharmaceutics, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur Dist.: Dhule 425405, Maharashtra State, India

✉*Corresponding author: L. R. Zawar, shwet.zawar@gmail.com*

[#]*These authors contributed equally to this work*

Received April 13, 2023

The present work anticipated crystallinity-tuned silk fibroin (SFIB)-sodium alginate floating microbeads (MB) as a candidate for nevirapine (NEV) sustained release. Briefly, crystallinity tuning was accomplished using solvent annealing. The changes in structural conformation of SFIB were validated using FTIR spectroscopy. Here, the tangent baseline method revealed changes in crystallinity of floating NEV-loaded SFIB-MB. Importantly, solvent annealing offers conversion of amorphous 'α-helix' to crystalline 'β-sheet' of SFIB, helping to modify drug release from the matrix of SFIB-sodium alginate. As well, NEV-loaded SFIB-MB demonstrated good floating profile. The NEV-loaded SFIB-MB with ethanol (ETH-6) annealing for 6 hours shows 25.853% drug release at 12 hours (pH = 1.2), compared to untreated NEV-loaded SFIB-MB (65.132%, 12 hours, log $p < 0.0001$). The release kinetics of batch ETH-6 revealed first-order release kinetics and Fickian diffusion ($n = 0.468$) was found to be the drug diffusion mechanism. Therefore, crystallinity-modified floating NEV-loaded SFIB-based MB will open a new door for modified drug delivery.

Keywords: silk fibroin, nevirapine, floating drug delivery, microbeads, crystallinity modulation, solvent annealing

INTRODUCTION

Since its inception, oral dosing has been the most common route for administration of a therapeutically active agent. It is crystal clear that the goal of oral dose formulation is to achieve drug absorption through the gastrointestinal tract (GIT). However, quick gastrointestinal movement may result in the partial release of the active agent to the targeted area. Hence, due to the rapid gastric emptying issue, it is difficult to retain the dosage from the stomach site, resulting in reduced dosage potency.[1] In light of current discoveries, modified oral dosage forms can effectively enable tailored drug incorporation.[2] Efforts are taken to establish a novel drug delivery system that can maintain active concentration in plasma within therapeutic ranges for extended periods. Moreover, it helps to diminish variability in plasma drug concentration at a fixed state by distributing the drug in a regulated and repeatable way.[3] Out of several types of dosage forms, researchers are particularly interested in the gastro retentive drug delivery system (GRDDS) for a specific drug that acts regionally and has absorption openings in the upper GIT.[4,5] For that purpose, swelling and expansion-mediated systems, floating systems, bio(muco)adhesive dosage forms, *etc.* have been developed. Principally, it has been achieved using different types of excipients selected based on the density of the material, shape, and size. Also, their adhesive behavior and swelling index (SI) need to be considered for intended pharmaceutical formulations.[6] Particularly, in GRDDS, researchers have been focused on floating drug delivery systems (FDDS). It is due to their simple process and high effectiveness in formulation development.[7,8] Moreover, it has been reported that the FDDS can extend the duration a dosage form spends in the stomach, hence increasing the drug's oral bioavailability.[9,10] The use of effervescent agents produces carbon dioxide gas that can result in disturbances in the microbial

Ind. J. Pharm. Edu. Res., 2023; 57(3s):s564-s572.
https://www.ijper.org

Original Article

Chitosan–Sesbania Gum Mediated pH-Responsive Polyelectrolyte Complexes for Targeted Delivery of Diclofenac Sodium: Preparation and Spectroscopical Evaluation

Vipul Chaudhari, Shraddha Tawade, Sopan Nangare, Kirti Rajput, Nitin Shirsath, Piyush Bafna, Laxmikant Zawar*

Department of Pharmaceutics, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur, Maharashtra, INDIA.

ABSTRACT

Background: The implementation of chitosan as an enhanced vehicle for drug delivery is an interesting domain in the pharmaceutical dosage form. The combination of commonly accessible natural polysaccharides like gum may provide a new arrangement of dosage forms such as polyelectrolyte complex. Such modern improvements facilitate the modulated release of active, which can be beneficial in avoiding adverse consequences. There have been no reports on chitosan and sesbania gum-based polyelectrolyte complexes for drug delivery applications to date. **Objectives:** The chitosan-sesbania gum polyelectrolyte complex was developed for modified drug delivery of diclofenac sodium. **Materials and Methods:** pH-responsive polyelectrolyte complexes were accomplished utilizing the coacervation technique. It forms complex due to the capability of chitosan amine groups and sesbania gum carboxylic functionality. **Results:** The SEM analysis assured the aggregated polyhedral shape particles with a smooth surface of the final polyelectrolyte complex. The Diffractogram of the polyelectrolyte complex resulted in an amorphous form of diclofenac. The polyelectrolyte complex batch (B:3) showed satisfactory drug entrapment capabilities. It showed 88.96% of the drug release in 8 hr (pH 6.8). Importantly, it is because of the unprotonated condition of sesbania gum containing hydrophilic functionality that offers boosted hydrogen bonding via interaction with dissolution medium containing water molecules. Therefore, it offers the insertion of water molecules into a complex followed by the swelling of a matrix. **Conclusion:** The developed chitosan-sesbania gum polyelectrolyte complex offers a pH-responsive sustained release of diclofenac sodium. In the future, chitosan and sesbania gum-based polyelectrolyte complex can be preferred as an innovative drug carrier for diclofenac sodium delivery.

Keywords: Chitosan, Sesbania gum, Diclofenac sodium, Polyelectrolyte complex, Drug delivery.

Correspondence:
Dr. Laxmikant R. Zawar (M. Pharm, Ph.D.)
Associate Professor, Department of Pharmaceutics, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur-425405, Maharashtra, INDIA.
Email: shwet.zawar@gmail.com

Received: 28-11-2022;
Revised: 14-03-2023;
Accepted: 23-06-2023.

INTRODUCTION

Presently, the use of polymeric-based systems for the delivery of active is opening a new era that may be because of their prospective applications. These methods control drug delivery rates, maintain therapeutic action, and/or target drugs to tissues. In addition, they enhance and modify physicochemical properties such as stability and solubility, which provide the therapeutic effects of drugs with greater benefits. Due to their bioadhesive nature, they have been utilized as matrices for drug administration via oral, buccal, transdermal, and nasal routes. However, they function as carrier systems for drugs, enzymes, or DNA because charged species may be conveniently incorporated into complex particles. These can be used as membranes, coatings on films and fibers, targeted nucleic acid delivery, nucleic acid isolation and fractionation, pharmaceutical product binding, preparation of microcapsules for drug delivery membranes for dialysis, contact lenses,[1] enzyme mimics,[2] medical applications,[3] nanoparticles for targeted tissue delivery, and the development of biosensors.[4]

Out of several kinds of polymeric systems, polyelectrolytes-based systems are recently reported that solely relied on charged-based components. Interestingly, two oppositely charged polyelectrolytes are simultaneously combined in solution without using any chemical covalent cross-linker leading to the formation of a polyelectrolyte complex.[5] The polyelectrolyte complex has attracted attention due to its nontoxicity and well-tolerated

DOI: 10.5530/ijper.57.3s.65

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 306 (2024) 123608

Contents lists available at ScienceDirect

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy

journal homepage: www.journals.elsevier.com/spectrochimica-acta-part-a-molecular-and-biomolecular-spectroscopy

Application of surface nitrogen-doped graphene quantum dots in the sensing of ferric ions and glutathione: Spectroscopic investigations and DFT calculations

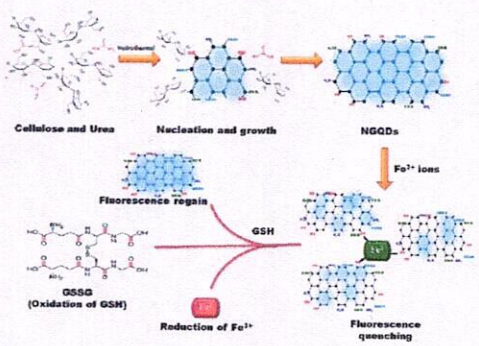
Zamir G. Khan, Tanisha N. Agrawal [1], Sanjaykumar B. Bari, Sopan N. Nangare, Pravin O. Patil [*]

Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research Shirpur, Dist. Dhule, Maharashtra 425 405, India

HIGHLIGHTS

- NGQDs were synthesized using bamboo fiber powder and urea as green precursors.
- The reliability of the fabricated NGQDs was demonstrated to sense Fe^{3+} and GSH.
- DFT calculations were used to understand the mechanism involved.
- The NGQD/Fe^{3+} system fabricated has the potential to detect GSH in real samples.

GRAPHICAL ABSTRACT



ARTICLE INFO

Keywords:
Graphene quantum dots
Glutathione
Green synthesis
Fluorescence biosensing
Bamboo fibre

ABSTRACT

Developing a sensing platform that can quickly and accurately measure glutathione (GSH) is crucial for the early detection of various human diseases. GQDs have shown great potential in many technological and biological applications. This study focused on synthesizing nitrogen-doped GQDs (NGQDs) with stable blue fluorescence using a simple and easy hydrothermal method in one step. The bamboo fiber was used as the green source for this synthesis. The NGQDs had a tiny particle size of 4.7 nm and emitted light at 405 nm when excited. They displayed a remarkable quantum yield of 40.36 % and were effectively used as fluorescent probe to specifically detect Fe^{3+}. The energy transfer mechanism led to the NGQDs' fluorescence being deactivated by Fe^{3+} ions (turn-"off"). However, with the addition of GSH to the system, the fluorescence intensity of NGQDs was reactivated (turn- "on"). Thus, a fluorescence turn "off–on" system was developed for the sensitive detection of Fe^{3+} and GSH. Using density functional theory (DFT), it was theoretically calculated that the surface of the fabricated NGQDs possess lone pairs of electrons on oxygens and doped nitrogen causing a photo-induced electron transfer (PET) process to occur. This PET process was suppressed previously owing to complex formation between oxygen atoms of modeled structure and ferric ions. The sensing platform displayed a sensitive response to Fe^{3+} in the 1–1000 μM range with LOD of 34 nM and GSH in the range of 1–50 μM, with a detection limit of 45 nM. Furthermore, the NGQDs exhibited high selectivity towards Fe^{3+} and GSH over other electrolytes and

* Corresponding author.
E-mail address: rxpatilpravin@yahoo.co.in (P.O. Patil).
[1] These authors contributed equally as the first author.

https://doi.org/10.1016/j.saa.2023.123608
Received 26 May 2023; Received in revised form 23 September 2023; Accepted 31 October 2023
Available online 3 November 2023

Journal of Photochemistry & Photobiology, A: Chemistry 446 (2024) 115158

Contents lists available at ScienceDirect

Journal of Photochemistry & Photobiology, A: Chemistry

journal homepage: www.elsevier.com/locate/jphotochem

Poly-L-lysine functionalized graphene quantum dots embedded zirconium metal–organic framework-based fluorescence switch on-off-on nanoprobe for highly sensitive and selective detection of taurine

Sopan Nangare [1], Kalyani Chaudhari [1], Pravin Patil [*]

Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur 425405, Dist: Dhule, Maharashtra State, India

ARTICLE INFO

Keywords:
Taurine
Graphene quantum dots
Metal–organic frameworks
UiO-66@NH_2 MOF
Cardiovascular disease

ABSTRACT

Taurine is now widely used as a novel diagnostic biomarker for cardiovascular disease. Unfortunately, engaged techniques for the analysis of taurine are suffering from low sensitivity, poor selectivity, and a tedious process. In this work, the poly-L-lysine functionalized graphene quantum dots embedded UiO-66@NH_2 metal–organic framework (PLL-fGQDs@UiO-66@NH_2 MOF) based turn 'On-Off-On' fluorescent nanoprobe was designed for taurine sensing. Initially, synthesized PLL-fGQDs, UiO-66@NH_2 MOF, and PLL-fGQDs@UiO-66@NH_2 MOF nanoprobe were confirmed using UV–Vis spectroscopy, FT-IR analysis, particle size analysis, fluorescence study, PXRD, SEM-EDAX, HR-TEM, etc. Here, anticipated PLL-fGQDs incorporation into UiO-66@NH_2 MOF nanoprobe portrayed a highly fluorescent nanoprobe for taurine sensing. The copper (Cu^{2+}) ions addition in the fluorescent nanoprobe resulted in fluorescence dampness followed by taurine addition showed the recovery of quenched fluorescence. Principally, it might be because of the greater binding affinity of Cu^{2+} ions towards taurine-containing oxygen atoms of a sulfonic group and the nitrogen atom of an amine group. The linear concentration range, limit of detection (LOD), and limit of quantification (LOQ) of taurine were found to be 5 ng/mL to 360 ng/mL, 2.91 ng/mL, and 8.84 ng/mL, respectively. It also provides a high selectivity towards taurine in the occurrence of interfering agents whereas practical applicability was assured by spiked artificial serum samples analysis. In conclusion, the designed PLL-fGQDs@UiO-66@NH_2 MOF nanoprobe offers high sensitivity, selectivity, good stability, repeatability, and practicability. In the future, it can be used as a new nanoprobe for taurine recognition with improved performance than the traditional methods.

1. Introduction

Presently, cardiovascular diseases (CVDs) are a leading consequence of mortality. Traditional approaches are unable to predict this increased risk [1]. In this shade, biomarker identification is pivotal in healthcare for diagnosis. Therefore, research scholars are now investigating for novel biomarkers for the diagnosis of plenty of serious disorders such as CVD [2]. Importantly, CVD can be managed satisfactorily at a preliminary phase by monitoring divergent biochemical values. In a sense, it is imperative to emphasize that CVD can be spotted at an initial stage by adopting an innovative biosensing strategy [3]. Taurine (2-aminoethanesulfonic acid) [4] is a free and necessary amino acid. It is present in a variety of body fluids, including plasma and urine. As well, it is committed to a variety of crucial biological processes [5]. As a result, taurine is a significant biomarker for the earliest identification of CVD [6]. In the literature, multiple methods have been developed for the determination of taurine [7,8]. Nonetheless, there are several shortcomings of these methods such as the difficult extraction, need for modern equipment, high pricing, prolonged detection process, etc., [9] that need to be overcome using advanced methods.

Carbon-based zero-dimensional (0D) nanomaterials namely graphene quantum dots (GQDs) are ordinarily prioritized for biomedical applications encompassing such diagnostics and others [10]. Mainly, GQDs are tiny graphene particles with diameters less than 100 nm [11]. It offers superior and dynamic physicochemical features which are important for the development of the sensing approach [12]. The surface

* Corresponding author at: Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur 425405, Dist: Dhule (MS), India.
E-mail address: rxpatilpravin@yahoo.co.in (P. Patil).
[1] These authors contributed equally as the first author.

https://doi.org/10.1016/j.jphotochem.2023.115158
Received 26 July 2023; Received in revised form 27 August 2023; Accepted 4 September 2023
Available online 14 September 2023

Inorganic Chemistry Communications 158 (2023) 111718

Contents lists available at ScienceDirect

Inorganic Chemistry Communications

journal homepage: www.elsevier.com/locate/inoche

Short communication

One pot synthesis of cobalt and nitrogen co-doped graphene quantum dots based fluorescence 'On-Off-On' probe for dimethoate sensing: A proof of concept

Mahendra R. Mahajan, Pravin O. Patil *

Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur, Dist., Dhule, MS 425405, India

ARTICLE INFO

Keywords:
Cobalt/ nitrogen doping
Graphene quantum dots
Dimethoate
Fluorescent sensor

ABSTRACT

Dimethoate, which is widely used in agriculture, has harmful effects on organs. To address this issue, advanced sensors are crucial for detecting it in real samples. Notably, graphene quantum dots (GQDs)-centered fluorescent sensors offer numerous advantages such as high sensitivity, selectivity, and good stability. Therefore, in this work, we designed a new cobalt/nitrogen co-doped GQD (Co/N-GQD) fluorescence switch "On-Off-On" sensor to achieve selective dimethoate detection. In brief, the synthesis of Co/N-GQDs, achieved through the hydrothermal method, involves *Pithecellobium dulce* fruit peel as a green precursor, along with cobalt (Co) and urea as dopant sources. Extensive spectral characterizations, including FTIR, UV–Vis spectroscopy, zeta potential analysis, particle size analysis, HR-TEM, Raman, PXRD, and fluorescence studies, were conducted to validate the fabrication of Co/N-GQDs. The resulting nanosized Co/N-GQDs exhibited an enhanced quantum yield of 49.78 %. In terms of sensing, the fluorescence intensity of Co/N-GQDs is selectively quenched ("Turned Off") by Cu^{2+} through a dynamic quenching mechanism. When dimethoate is included in the quenching system, a proportional correlation is observed between dimethoate concentration and fluorescence reactivation. This phenomenon is attributed to the potential of dimethoate, which contains amide and phosphorodithioate functionalities, to displace Cu^{2+} from the electrostatic complex through chelation. Remarkably, the sensor achieves a limit detection limit (LOD) of 64.08 ng/mL, offering a broad linear range spanning from 10 to 800 ng/mL. In addition, it exhibited real-time applicability, good stability, and reproducibility. In conclusion, the design of Cu^{2+}–Co/N-GQDs can be used as a proof of concept for dimethoate sensing within various sample contexts.

1. Introduction

In today's modern era, organophosphorus pesticides (OPPs) play an important role in crop protection globally. These pesticides are highly regarded for their potent insecticidal action, water solubility, and rapid degradation [1]. Despite their benefits, long-term OPP presence in agriculture, soil, and water threatens health and survival [2]. Dimethoate, a thio-organophosphate, finds global use but is banned in Europe due to harm [3]. Still, it is used in parts of Asia, Africa, Brazil, and the USA, raising significant concerns about its potential risks and effects [4]. Dimethoate exerts its toxicity by irreversibly inhibiting the enzyme acetylcholinesterase (AChE), leading to organ dysfunction and death [5]. In alignment with this, the World Health Organization (WHO) has established a supremely acceptable dose of dimethoate at 0.002 mg/kg of total body weight [6]. This chemical can harm multiple organs [7]. Hence, it is crucial to closely monitor and control the presence of OPPs in food, water, and the environment, demanding special attention to each of these aspects. Numerous conventional techniques have been explored for monitoring dimethoate, such as spectrophotometry [8], thin layer chromatography (TLC) [9], liquid chromatography-mass spectrometry (LC-MS) [10], high-performance liquid chromatography (HPLC) [11], and gas chromatography (GC) [12]. These methods offer highly sensitive, selective, and quantitative monitoring of dimethoate. However, they come with inherent drawbacks such as expensive equipment, complex operations, time-consuming pre-treatment, and the need for experienced operators [13]. Consequently, the academic and scientific community is closely focusing on alternative sensor technologies to track various pesticides. In brief, inorganic quantum dots, such as cadmium telluride/cadmium sulfide-based sensors, have been utilized for monitoring OPPs. However, they have some drawbacks in terms of

* Corresponding author.
E-mail address: rxpatilpravin@yahoo.co.in (P.O. Patil).

https://doi.org/10.1016/j.inoche.2023.111718
Received 1 September 2023; Received in revised form 26 October 2023; Accepted 8 November 2023
Available online 10 November 2023

International Journal of Biological Macromolecules 256 (2024) 128392

Contents lists available at ScienceDirect

International Journal of Biological Macromolecules

journal homepage: www.elsevier.com/locate/ijbiomac

Design of lactoferrin functionalized carboxymethyl dextran coated egg albumin nanoconjugate for targeted delivery of capsaicin: Spectroscopic and cytotoxicity studies

Hrishikesh Rajput [a,b,1], Sopan Nangare [a,1], Zamir Khan [a], Ashwini Patil [a], Sanjaykumar Bari [a,b], Pravin Patil [a,*]

[a] Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur-425405, Dist: Dhule, MS, India
[b] Department of Quality Assurance, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur-425405, Dist: Dhule, MS, India

ARTICLE INFO

Keywords:
Lactoferrin
Colorectal cancer
Carboxymethyl dextran
Egg albumin
Capsaicin

ABSTRACT

The increased mortality rates associated with colorectal cancer highlight the pressing need for improving treatment approaches. While capsaicin (CAP) has shown promising anticancer activity, its efficacy is hampered due to low solubility, rapid metabolism, suboptimal bioavailability, and a short half-life. Therefore, this study aimed to prepare a lactoferrin-functionalized carboxymethyl dextran-coated egg albumin nanoconjugate (LF-CMD@CAP-EGA-NCs) for the targeted CAP delivery to enhance its potential for colorectal cancer therapy. Briefly, LF-CMD was synthesized through an esterification reaction involving LF as a receptor and CMD as a shell. Concurrently, CAP was incorporated into an EGA carrier using gelation and hydrophobic interactions. The subsequent production of LF-CMD@CAP-EGA-NCs was achieved through the Maillard reaction. Spectral characterizations confirmed the successful synthesis of smooth and spherical-shaped LF-CMD@CAP-EGA-NCs using LF-CMD and EGA-CAP nanoparticles, with high entrapment efficiency and satisfactory drug content. Furthermore, LF-CMD@CAP-EGA-NCs demonstrated a sustained release of CAP (76.52 ± 1.01 % in 24 h, $R^2 = 0.9966$) in pH 5.8 buffer with anomalous transport ($n = 0.68$) owing to the shell of the CMD and EGA matrix. The nanoconjugate exhibited enhanced cytotoxicity in HCT116 and LoVo cell lines, which is attributed to the overexpression of LF receptors in colorectal HCT116 cells. Additionally, LF-CMD@CAP-EGA-NCs demonstrated excellent biocompatibility, as observed in the FHC-CRL-1831 cell line. In conclusion, LF-CMD@CAP-EGA-NCs can be considered as a promising approach for targeted delivery of CAP and other anticancer agents in colorectal cancer treatment.

1. Introduction

Colorectal cancer ranks third in prevalence and second in severity among various cancer types [1]. Surgery remains the most favorable option for treating early colorectal cancer [2]. Unfortunately, over half of cancer patients experience recurrence and metastasis following surgical resection [3,4]. In such patients, chemotherapy and radiation have emerged as reliable treatment options [5]. For instance, clinical trials have shown the potential of irinotecan, oxaliplatin, and capecitabine in treating colorectal cancer [2]. However, prolonged chemotherapy results in drug resistance and significant damage to normal tissues [6,7]. While useful, both radiation and chemotherapy suffer from multiple limitations such as lack of selectivity, dose-dependent toxicity, and development of resistance [5,8]. Systemic delivery of chemotherapeutic agents has shown to be useful in managing colorectal cancer [9]. Studies have reported the efficacy of systemically administered FOLFIRI (5-fluorouracil/leucovorin and irinotecan) and FOLFOX (5-fluorouracil/leucovorin and oxaliplatin) in the treatment of metastatic colorectal cancer [10]. The implementation of systemic treatment in colorectal cancer improves the survival of cancer patients [11]. In addition, the use of modified nanocarriers along with anticancer drugs has yielded synergistic benefits, including targeted delivery and the potential for concurrent administration in systemic treatment [9].

Capsaicin (CAP) has gained considerable attention in cancer therapy

* Corresponding author.
E-mail address: rxpatilpravin@yahoo.co.in (P. Patil).
[1] These authors contributed equally as the first authors.

https://doi.org/10.1016/j.ijbiomac.2023.128392
Received 24 June 2023; Received in revised form 21 November 2023; Accepted 22 November 2023
Available online 27 November 2023

Scientific paper

Zinc Metal-Organic Frameworks- Graphene Quantum Dots Nanocomposite Mediated Highly Sensitive and Selective Fluorescence "On-Off-On" Probe for Sensing of Quercetin

Sopan N. Nangare[1], Premnath M. Sangare[2], Ashwini G. Patil[3] and Pravin O. Patil[2,*]

[1] *Department of Pharmaceutics, H. R. Patel Institute of Pharmaceutical Education and Research, hirpur 425405, Dist: Dhule (MS), India.*

[2] *Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur 425405, Dist: Dhule (MS), India.*

[3] *Department of Microbiology, R. C. Patel Arts, Commerce and Science College, Shirpur 425405, Dist: Dhule (MS), India.*

* *Corresponding author: E-mail: rxpatilpravin@yahoo.co.in*

Received: 11-03-2022

Abstract

The current study presents a fluorescence-based 'On-Off-On' nanoprobe composed of rose petal-derived graphene quantum dots embedded in zinc metal-organic frameworks (RP-GQDs@Zn-MOFs) as a proof of concept for quercetin sensing. The particle size and HR-TEM analysis confirmed the synthesis of a uniformly distributed nanosized probe, while the zeta potential (+33.03 mV) verified its good stability. The fluorescence analysis confirmed that the introduction of copper ions (Cu^{2+}) resulted in fluorescence quenches, while the inclusion of quercetin forms quercetin-Cu^{2+} complex, leading to recovery of quenched fluorescence in RP-GQDs@Zn-MOFs due to static quenching. The nanoprobe demonstrated a wide concentration range and a low detection limit of 100 ng/mL to 1400 ng/mL (R^2 = 0.99) and 37.8 ng/mL, respectively. Selectivity analysis highlighted pronounced specificity for quercetin, attributed to Cu^{2+} coordination between carbonyl oxygen atom and the 3-OH group of quercetin. Furthermore, designed probe exhibited excellent stability, repeatability (RSD < 5), and potential for real-time analysis.

Keywords: Zinc metal-organic frameworks; graphene quantum dots; copper ions; quercetin; high sensitivity; high selectivity

1. Introduction

Metal-organic frameworks (MOFs) are preferred for various applications, including biomedical and environmental uses. This preference stems from their distinctive characteristics, such as their ability to modify surfaces, their large surface area, and their adjustable structure.[1] It provides a highly porous structure through the association of metal ions with carefully selected organic linkers via strong bonding.[2] To date, various types of MOFs have been developed for numerous applications, including drug delivery, biosensing, chemical sensing, gas separation, and more.[3,4] At present, they are widely employed for biosensing purposes, offering low detection limits, high sensitivity, excellent responsiveness, and good stability, among other benefits.[4] Despite these groundbreaking merits, MOFs suffer from major drawbacks, primarily the collapse of their structure and pore shrinkage.[2] As a result, there is a need for complementary nanoparticles that can help overcome these significant drawbacks while preserving the original features of MOFs.

Currently, significant efforts are underway to develop innovative MOFs-centered composites to address the genuine needs of the scientific community. Encapsulating nanosized components within MOFs represents a novel advancement in the biomedical field.[5,6] In this context, it is worth noting that fluorescence-mediated sensing tech-

Microchemical Journal 193 (2023) 109056

Contents lists available at ScienceDirect

Microchemical Journal

journal homepage: www.elsevier.com/locate/microc

Review Article

Nanosize design of carbon dots, graphene quantum dots, and metal–organic frameworks based sensors for detection of chlorpyrifos in food and water: A review

Mahendra R. Mahajan, Sopan N. Nangare, Pravin O. Patil *

Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur, Dist.: Dhule (MS), 425405, India

ARTICLE INFO

Keywords:
Chlorpyrifos
Pesticide, organophosphorus compunds, carbon dots
Graphene quantum dots
Metal–organic framework

ABSTRACT

Chlorpyrifos (CPS) is a pesticide that is extensively used in agriculture. Despite their significant advantages in agriculture, small amounts of CPS in food and water have serious negative effects on human health and the environment. As a result, the detection of CPS with high sensitivity and selectivity is an urgent need. Unfortunately, conventional methods have numerous shortcomings such as low sensitivity, poor selectivity, low stability, complex procedures, etc. Nowadays, smart nanomaterials such as carbon dots (CDs), graphene quantum dots (GQDs), and metal–organic frameworks (MOFs) are widely reported for sensing CPS because of their unique characteristics such as good stability, tunability, high surface area, optical and electrical properties, etc. Therefore, the present review article provides insights into advanced nanoarchitecture-based smart nanomaterials namely CDs, GQDs, and MOFs mediated sensors for highly sensitive and selective sensing of CPS in water and food. Initially, the concept of CPS toxicity and the need to detect CPS are reviewed. Following this, smart advanced nanomaterial-based fluorescent, electrochemical, and colorimetric sensors for CPS monitoring in food and water are described. Finally, the current challenges and future promises of CDs, GQD, and MOF-based smart nanomaterials for CPS sensing are addressed. As an output, CDs, GQD, and MOF-based sensors provide the lowest detection limits down to femtograms (fg) for CPS detection. In addition, the reported sensors show high selectivity, good stability, and real-time applicability. In conclusion, CDs, GQDs, and MOFs-based sensing systems for CPS revealed superior performance over conventional methods. Therefore, in the future, this study will provide insights to budding researchers to design ultramodern smart nanomaterial-mediated sensors for real-time applications.

1. Introduction

Since their inception, organophosphorus pesticides (OPPs) have been utilized most effectively to kill insects [1]. According to a literature review, pesticide utilization increased from 3.1 to 4.1 million tons between 1999 and 2018 [2]. Mainly, OPPs are categorized into four primary groups such as phosphates, phosphorothioates, phosphorodithioates, and phosphorothiolates [3]. In this case, a few of the most popularly utilized OPPs include diazinon, dichlorvos, dimethoate, fenitrothion, quinalphos, monocrotophos, CPS, malathion, parathion, etc. [4]. Despite the plenty of merits of OPPs, the residues of OPPs are frequently found in air, soil, groundwater, and even agricultural commodities. Moreover, these pesticides are extremely poisonous and their residues are detrimental to living organisms and the atmosphere [5]. Out of these pesticides, CPS is a potent insecticide employed in crop fields to eradicate termites, mosquitoes, roundworms, maize rootworms, flea beetles, flies, fire ants, and other pests [6]. It gives the broad-spectrum ability to kill weeds and insects [7]. Primarily, China is the world's largest producer of CPS and India is a major consumer of CPS. Also, it is widely used in the United States, Brazil, and Cyprus [8]. To the best of our knowledge, the CPS was invented by a German scientist in the 1930 s. Later, in 1965, Dow Chemical Corporation introduced CPS to the United States for household and agricultural applications [9]. As per WHO categorization, CPS is a second-class OPPs with moderate toxicity. As well, CPS ($C_9H_{11}Cl_3NO_2PS$; *O*, *O*-diethyl-*O*-(3,5,6-trichloro-2-pyridinyl) phosphorothioate) is a non-systemic chlorinated OPPs insecticide. Also, it is used as an acaricide and nematicide. The CPS is a crystalline solid that is white or colorless and has a faint mercaptan

* Corresponding author.
E-mail address: rxpatilpravin@yahoo.co.in (P.O. Patil).

https://doi.org/10.1016/j.microc.2023.109056
Received 17 April 2023; Received in revised form 13 June 2023; Accepted 23 June 2023
Available online 7 July 2023

Journal of Drug Delivery Science and Technology 82 (2023) 104325

Contents lists available at ScienceDirect

Journal of Drug Delivery Science and Technology

journal homepage: www.elsevier.com/locate/jddst

Preparation of pirfenidone loaded chitosan-polyvinyl alcohol-graphene oxide-based scaffold: Spectroscopical characterizations and antibacterial activity

Dinesh D. Borhade [a,1], Sopan N. Nangare [b,1], Dilip A. Patil [b], Pravin O. Patil [b], Gaurav S. Patil [a], Ganesh B. Patil [a,*]

[a] Department of Pharmaceutics, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur, 425405, Dhule, Maharashtra state, India
[b] Department of Pharmaceutical Chemistry, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur, 425405, Dhule, Maharashtra state, India

ARTICLE INFO

Keywords:
Chitosan
Polyvinyl alcohol
Graphene oxide
Pirfenidone
Antibacterial activity

ABSTRACT

The antibacterial activity against *Staphylococcus aureus (S. aureus)* in diabetic foot wound treatment is an appealing area for budding researchers. In this case, drug-loaded chitosan (CS)/polyvinyl alcohol (PVA)/graphene oxide (GO)-based composites can be used as an excellent option for antibacterial activity in diabetic foot wound treatment. Therefore, the present study aims to design a pirfenidone-loaded CS/PVA/GO nanocomposite (PFD-CS/PVA/GO) based scaffold via solvent casting method for improved antibacterial activity. In brief, CS with PVA forms the polyelectrolyte complex due to hydrogen bonding between amine functionality (CS) and a hydroxyl group (PVA). The GO nanosheet addition into CS/PVA resulted in covalent bonding between the amine functionality (CS) and the carboxylic functionality (GO) whereas PFD was fixed in CS/PVA/GO via π-π stacking. In this study, optimized PFD-CS/PVA/GO (6% w/w) scaffold percent entrapment efficiency, tensile strength, moisture content, % drug release, % swelling degree, % elongation at break, and water retention capacity were found to be 77.60%, 70.35 g/cm^2, 16.39%, 50.60% (7 days), 236%, 45%, and 543.47%, respectively. Release kinetics assured that the Higuchi matrix was the best-fit model (R^2 = 0.99). Interestingly, the GO avoids burst drug release at the beginning followed by extending the release whereas CS into PFD-CS/PVA/GO provides a good adhesive ability. Finally, antibacterial activity against *S. aureus* of PFD-CS/PVA/GO (6% w/w) shows a high (12.06 mm) zone of inhibition over a separate component of the scaffold. Concisely, optimized PFD-CS/PVA/GO (6% w/w) scaffolds provide improved antibacterial potential owing to their combined benefits of CS, and GO. In the future, anticipated PFD-CS/PVA/GO scaffolds will open a new door for antibacterial potential in diabetic foot wound healing.

1. Introduction

Diabetes mellitus (DM) is a critical condition in the healthcare sector. Epidemiological studies indicate approximately 285 million cases of DM in 2010 whereas it would be more than 360 million cases of DM in 2030. As per the literature, DM patients are susceptible to several problems wherein diabetes chronic foot wounds are one of them [1]. Unfortunately, diabetes chronic foot wounds take longer to heal because of disruptions in the process of collagen synthesis [2]. In addition, diabetic food infection is associated with poly-microbial infections. In that, *Staphylococcus aureus (S. aureus)* is the most common pathogen. Presently, with the continuous preferences for antibiotics, there are chances of antimicrobial resistance for this pathogen [3]. To treat this critical healing condition of patients, several types of advanced approaches have been revealed. Current treatment approaches incorporating active for particular tasks, such as nanoparticles, nanogels, beads, biofilms, bandages, nanofibrous membranes, and so on, are unable to provide the necessary effects [2]. In addition, available therapies including tissue transplants, bioengineered skin, growth factors, hyperbaric oxygen treatment, and negative pressure wound therapy have shown healing

* Corresponding author. author. Department of Pharmaceutics, H. R. Patel Institute of Pharmaceutical Education and Research, Shirpur, Dhule, 425405, Maharashtra state, India.
E-mail address: ganu16@gmail.com (G.B. Patil).
[1] These authors contributed equally as the first authors.

https://doi.org/10.1016/j.jddst.2023.104325
Received 8 December 2022; Received in revised form 25 February 2023; Accepted 28 February 2023
Available online 1 March 2023

Review

Nano Biomed Eng

Artificial Intelligence in the Paradigm Shift of Pharmaceutical Sciences: A Review

Rahul S. Tade ✉, Swapnil N. Jain, Janhavi T. Satyavijay, Pratham N. Shah, Tejaswi D. Bari, Tanushri M. Patil, Ruhi P. Shah

Department of Pharmaceutics, H.R. Patel Institute of Pharmaceutical Education and Research, Shirpur, Maharashtra 425405, India

✉ Corresponding author. E-mail: taderahul2011@yahoo.com

Received: Jul. 30, 2023; **Revised:** Sep. 26, 2023; **Accepted:** Oct. 19, 2023

Citation: R.S. Tade, S.N. Jain, J.T. Satyavijay, et al. Artificial intelligence in the paradigm shift of pharmaceutical sciences: a review. *Nano Biomedicine and Engineering*, 2023.

http://doi.org/10.26599/NBE.2023.9290043

Abstract

AI has emerged as a revolutionary technology in the pharmaceutical and biomedical fields. This review explores its transformative role, particularly in drug development, the discovery of future interventions in the pharmaceutical sector. By leveraging AI, these processes have become more efficient, cost-effective, and capable of delivering personalized medicine to individual patients. Moreover, AI's potential in disease prevention and outbreak prediction is promising, as it can analyze vast datasets to identify crucial patterns and trends, leading to targeted interventions for combating diseases. In biomedical research, AI has proven highly beneficial, especially in genomics, proteomics, and metabolomics, where it enables researchers to comprehensively analyze complex biological data, uncovering new insights and accelerating scientific discoveries. The impact of AI is also evident in the patient-physician interface, as it enhances diagnostic accuracy and treatment efficiency, ultimately improving patient care.

Keywords: artificial intelligence (AI); pharmaceutical research; drug discovery; academic research; precision medicine; job market

Introduction

Artificial intelligence (AI) has brought about a significant revolution in various sectors, with pharmaceutical research being no exception. This cutting-edge technology holds tremendous potential to accelerate medication development, improve patient outcomes, and reduce costs. Pharmaceutical research is a complex and time-consuming process encompassing drug discovery, development, clinical trials, and regulatory approval. AI's integration into these stages, as well as academic and industrial research and the biomedical industry, can prove highly impactful [1]. The initial phase of pharmaceutical research involves drug discovery and development, which includes identifying and validating therapeutic targets, designing molecules, and testing their efficacy and safety. This step typically takes years and requires substantial resources and expertise. However, AI can streamline the process by analyzing vast datasets, predicting molecular interactions, and optimizing drug design [2].

For instance, AI algorithms can efficiently analyze genomic and proteomic data to identify potential drug targets and predict the effectiveness of specific drug