

## RESEARCH ARTICLE

# Role of aromatic ring spacer in homo-coupled conjugated microporous polymers in selective CO<sub>2</sub> separation

Sachin Tanaji Mane<sup>1</sup> | D. G. Kanase<sup>1</sup> | Suhas Mohite<sup>2</sup>

<sup>1</sup>Department of Chemistry, Bharati Vidyapeeth's Dr. Patangrao Kadam Mahavidyalaya, Sangli, Maharashtra, India

<sup>2</sup>Department of Chemistry, Bharati Vidyapeeth Deemed University, Yashwantrao Mohite College, Pune, Maharashtra, India

**Correspondence**

Sachin Tanaji Mane, Department of Chemistry, Bharati Vidyapeeth's Dr. Patangrao Kadam Mahavidyalaya, Sangli, Maharashtra 416416, India. Email: stm2011.mane@gmail.com.

**Abstract**

To obtain high purity of natural and flue gases, the development of adsorbent with appropriate structure is of great importance. As a result, there is an urgent need to investigate the role of aromatic ring spacer in adsorbent in high CO<sub>2</sub> capture. For this, conjugated microporous polymers (CMPs) were fabricated through homo-coupling reaction of 1,3,5-tribromobenzene (TBB) and 1,3,5-triethynylbenzene (TEB). It was observed that, CMP-A (without spacer) demonstrates high CO<sub>2</sub> uptake over CMP-B (with spacer). CMP-A demonstrates CO<sub>2</sub> uptake of 212.1 mg g<sup>-1</sup> which is obviously higher than benchmark adsorbents under the analogous conditions. In addition, the obtained CO<sub>2</sub> uptake is also higher than metal-organic framework (MOF) and energy-intensive carbon-based adsorbents. CMP-A revealed high CO<sub>2</sub>/N<sub>2</sub> selectivity (78.5) over CMP-B (56.1). It was noticed that CMP-A demonstrates excellent CO<sub>2</sub>/CH<sub>4</sub> and CO<sub>2</sub>/N<sub>2</sub> selectivity over CMP-B at 273 K. This is mainly due to appropriate structure in CMP-A (without spacer). The obtained CO<sub>2</sub>/N<sub>2</sub> selectivity (78.5) is higher than recently reported adsorbents under the similar experimental conditions.

**KEYWORDS**

CO<sub>2</sub> capture, conjugated polymers, homo-coupled polymers, microporous polymers

## 1 | INTRODUCTION

Today, natural and flue gases are the major sources of clean energy. Indeed, raw natural and flue gas mainly consists of methane and nitrogen, respectively along with CO<sub>2</sub> as a major impurity. To obtain enhanced calorific value of natural and flue gas, selective removal of CO<sub>2</sub> is an essential. Till date, different functional sorbents were developed for selective CO<sub>2</sub> separation. The primary advantage of functional sorbents is the high CO<sub>2</sub> selectivity in comparison with non-functional carbon-based sorbents.<sup>1</sup> To improve the selectivity of CO<sub>2</sub> over CH<sub>4</sub> and N<sub>2</sub>, incorporation of the polar functional groups such as -OH, -NH-, -S-, -O-, and -F are well-known strategy.<sup>2,3</sup> On the one hand, these polar functional groups obviously enhance the interaction

of sorbent and acidic CO<sub>2</sub> over CH<sub>4</sub> and N<sub>2</sub>. On the other hand, polar functional sorbents also enhance affinity for atmospheric moisture which results into decreased CO<sub>2</sub> uptake.<sup>4,5</sup> Moreover, porous polymer network-6 (PPN-6) after tethering with alkylamines exhibited a high isosteric heat of adsorption ( $Q_{st}$ ), with a value up to 60 kJ mol<sup>-1</sup> contributes to chemisorption which results into energy-intensive regeneration of adsorbent.<sup>6</sup> Thus, functional sorbents have the drawbacks of low adsorption capacity and high heat of adsorption. Therefore, development of carbon based porous sorbents is needed for high CO<sub>2</sub> uptake and energy-saving regeneration.

Recently, there is potential development of solid sorbents for selective CO<sub>2</sub> capture.<sup>7</sup> Porous sorbents such as zeolites, activated carbons, and metal-organic frameworks



# Recent Developments in Chiral Stationary Phases: A Mini-Review

Sachin Tanaji Mane<sup>1\*</sup>, Dhanaji Govindrao Kanase<sup>1</sup>

<sup>1</sup>Department of Chemistry, Bharati Vidyapeeth's Dr. Patangrao Kadam Mahavidyalaya, Sangli-416416, Maharashtra, India.

## ABSTRACT

The purification of racemic drugs into enantiopure drugs is an extreme demand of the pharmaceutical industry. In racemic drugs, two or more enantiomers are often present. In these isomers, one isomer may be pharmacologically active whereas another isomer(s) may be inactive or in teratogenic (toxic) form. The resolution of pharmacologically active isomer from inactive or teratogenic isomer is an extreme need. As a result, the development of resolution techniques to obtain the enantiopure drug is very essential to treat the disease. In the present review, recent developments of different chiral stationary phases (CSPs) such as pirkle, polysaccharides and polypeptides, inclusion, ligand-exchange, macrocyclic antibiotics, and miscellaneous CSPs in a resolution of racemic drugs/mixtures are discussed. The progress of these CSPs in high performance liquid chromatography (HPLC), gas chromatography (GC), capillary electrophoresis (CE), supercritical fluid chromatography (SFC), and simulated moving bed (SMB) chromatography is discussed. Different interactions between CSPs and analytes which attributes for resolution of racemic drugs are also discussed.

**Key Words:** Racemates, Racemic drugs, Chiral separation, Enantiopurification, Chiral stationary phases

eIJPPR 2022; 12(1):44-53

**HOW TO CITE THIS ARTICLE:** Mane ST, Kanase DG. Recent Developments in Chiral Stationary Phases: A Mini-Review. Int J Pharm Phytopharmacol Res. 2022;12(1):44-53. <https://doi.org/10.51847/ywEtn2HoHl>

## INTRODUCTION

The mixture of two or more enantiomers wherein one enantiomer may be pharmacologically active and another enantiomer(s) may be equal/less potent, inactive, or toxic can be referred to as a Racemate. Over the past few decades, drugs were used in the form of a racemate to treat the diseases. The thalidomide tragedy first time underlined the importance of drug resolution [1]. In this tragedy, due to the presence of toxic isomer along with pharmacological isomer, 10000 children were born with phocomelia congenital disorder. Indeed, each enantiomer in the racemate is selective toward the pharmacological effect. Therefore, the resolution of racemates into enantiopure drugs by different resolution techniques is important and is a demand in organic and pharmaceutical chemistry [2]. The significance of chirality in drug design and development is discussed in the literature [3].

In some cases, synthesis of enantiopure molecules is not possible since enantiopurity of the product depends on regio-, chemo- and stereo-selectivity of the chiral catalysts, reagents, substrates, or other chiral entities [4-12].

Therefore, synthesis of the racemate and subsequent resolution is needed. Different methods such as chiral catalysis, chiral pool, chiral reagent, asymmetric synthesis (chiral substrate and chiral auxiliary) [7-11], crystallization [13], and resolution (direct and indirect) are the ways to obtain enantiopure molecules [14, 15]. The optical purity of enantiopure molecules can be determined by an enantiomeric excess which can be examined by different analytical techniques such as chromatographic, spectroscopic, light, and thermal methods. The analytical techniques such as gas chromatography (GC) [16], supercritical fluid chromatography (SFC) [17], simulated moving bed (SMB) chromatography [18], high performance liquid chromatography (HPLC) [19], capillary electrophoresis (CE) [20], thin layer chromatography (TLC) [21], nuclear magnetic resonance (NMR) [22], circular dichroism (CD) [23], X-ray diffraction [24], isotopic dilution (ID) [25], differential scanning calorimetry (DSC) [26], polarimetry [27], and some miscellaneous methods [28] are available for optical purity (enantiomeric excess) determination. Some of them are useful for analytical (qualitative) purposes and some

**Corresponding author:** Sachin Tanaji Mane

**Address:** Department of Chemistry, Bharati Vidyapeeth's Dr. Patangrao Kadam Mahavidyalaya, Sangli-416416, Maharashtra, India.

**E-mail:** [stm2011.mane@gmail.com](mailto:stm2011.mane@gmail.com)

**Received:** 12 December 2021; **Revised:** 23 February 2022; **Accepted:** 23 February 2022





# Influence of Zn-substitution on structural, morphological, electrical, and gas sensing properties of $Zn_xAl_2O_4$ ( $x = 0.1$ to $0.5$ ) synthesized by a sol-gel auto-combustion method

Rina R. Tikare<sup>a</sup>, Rohit R. Powar<sup>b,\*</sup>, Vinayak G. Parale<sup>c</sup>, Hyung-Ho Park<sup>c</sup>, Tukaram J. Shinde<sup>d</sup>, Dhanaji G. Kanase<sup>a,\*\*</sup>

<sup>a</sup> Metal Oxide Research Laboratory, Dr. Patangrao Kadam Mahavidyalaya, Sangli, 416416, Maharashtra, India

<sup>b</sup> Department of Chemistry, Shahid Virpatni Laxmi Mahavidyalaya, Titave, 416208, Maharashtra, India

<sup>c</sup> Department of Materials Science and Engineering, Yonsei University, Seoul, 03722, Republic of Korea

<sup>d</sup> P. G. Department of Physics, Smt. K.R.P. Kanya Mahavidyalaya, Islampur, 415409, Maharashtra, India

## ARTICLE INFO

### Keywords:

Sol-gel auto-combustion method  
XRD  
FTIR  
TEM  
Selectivity  
Gas sensor

## ABSTRACT

The nanosphere decorated needle-like morphology of zinc-substituted aluminate having general formula  $Zn_xAl_2O_4$  ( $x = 0.1, 0.2, 0.3, 0.4,$  and  $0.5$ ) (ZAN) samples were synthesized by a sol-gel auto-combustion method. The phase formation and stability temperature were confirmed by TG-DTA analysis. XRD study confirmed the formation of a cubic spinel structure of ZAN samples. The effect of Zn-substitution on structural and morphological properties of aluminate were investigated using X-ray diffraction (XRD), Fourier transforms infrared spectroscopy (FTIR), Transmission electron microscopy (TEM), Field emission scanning electron microscopy (FESEM), and Energy dispersive X-ray analysis (EDAX). The D.C. electrical resistivity study of ZAN samples revealed that resistance decreased with increasing temperature confirmed semiconducting nature. Nanosphere existing on micro-needles of zinc-substituted aluminate gas sensor revealed sensing to several analyte gases such as  $H_2S$ ,  $Cl_2$ ,  $CH_3OH$ ,  $SO_2$ , and  $NO_2$  working at room temperature to  $300^\circ C$ . The  $Zn_{0.4}Al_2O_4$  compositional gas sensor produced the highest response at operating temperature  $200^\circ C$  to 100 ppm  $H_2S$ . The results revealed that the prepared nanosphere decorated needles of the ZAN sensor was sensitive and selective to  $H_2S$  gas.

## 1. Introduction

At present, owing to protection and environmental control criteria, gas sensors have received excellent attention. The air pollution has now been tremendously intensified due to the rapid industrialization and an enormous amount of vehicle produced contaminants such as gases, volatile organic compounds (VOCs), suspended particulate matter (SPM), etc. Some oxidizing or reducing gases or vapors such as  $CO_2$ ,  $Cl_2$ ,  $NO_2$ , and ammonia are found to be harmful and cause allergic and breathing diseases like rhinitis and bronchial asthma [1]. Particularly air pollution was enormously hazardous as it is associated with the respiratory system. Generally, contaminated surrounding contains harmful, dangerous, or toxic gases adversely affected human health. Thus air pollution became a major issue due to stringent surrounding or safety guidelines all over nations. Hopefully, the researchers willing to

evaluate the ability to manufacture reactive material that is simple and low-cost to track air pollution at their sources. Hydrogen sulfide ( $H_2S$ ) is a colorless, slightly heavier than air, combustible gas, and very cruel with a typical foul odor of rotten egg [1,2].  $H_2S$  gas is one of the highly toxic gases emitted by various industrial effluent treatment plants, oil refineries, oil and gas drilling plants, Kraft paper mills, tanneries, thermal power plants, etc. [3]. To minimize health hazards and eruption tragedies,  $H_2S$  gas must be identified at (ppm/ppb) trace level for personal health protection to unnecessary exposure of the  $H_2S$  gas climate. The respiratory tract diseases occurred in employees due to intense exposure to  $H_2S$  gas. At concentrations ranging from 10 to 500 ppm of  $H_2S$  gas, the National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) decide criteria for adverse health effects due to exposure [1,4].

\* Corresponding author.

\*\* Corresponding author.

E-mail addresses: [rohitpowar009@gmail.com](mailto:rohitpowar009@gmail.com) (R.R. Powar), [dgkanase@gmail.com](mailto:dgkanase@gmail.com) (D.G. Kanase).

<https://doi.org/10.1016/j.ceramint.2020.11.021>

Received 3 September 2020; Received in revised form 24 October 2020; Accepted 4 November 2020

Available online 6 November 2020

0272-8842/© 2020 Elsevier Ltd and Techna Group S.r.l. All rights reserved.

# Monitoring and Assessment of Water Quality using Multivariate Statistics of Physico-chemical Parameters to establish Baseline Level around proposed Jaitapur Nuclear Power Plant (JNPP), India

Shinde R.D.<sup>1</sup>, Burungale S.H.<sup>2</sup>, Supale A.R.<sup>3</sup>, Chikode P.P.<sup>1</sup> and Sabale S.R.<sup>1\*</sup>

1. Jaysingpur College, Jaysingpur-416101, Maharashtra, INDIA

2. Yashwantrao Chavan College of Science, Karad-415174, Maharashtra, INDIA

3. Dr. P. K. Mahavidyalaya, Sangli-416416, Maharashtra, INDIA

\*srsabale@gmail.com

## Abstract

This study illustrates the usefulness of multivariate statistical techniques to provide straightforward data interpretation as well as valuable insights of datasets to get better information about the water quality and helps to design monitoring networks for effective management of available water resources. In this study, Multivariate statistical analysis, Cluster analysis, Principal Component Analysis, Factor Analysis, Water Quality Index and Piper diagram are used to analyze the water data and to prepare the baseline of water parameters around the proposed JNPP. Piper diagram indicates that the primary salinity ("non-carbonate alkali") exceeds 50 % which means that the chemical properties of water are dominated by alkalies and strong acids. Water quality indices indicate that water is non-polluted and fully fit for drinking purposes.

Principal component analysis and factor analysis applied for water parameters point towards the common source of minerals and high level of dissolved organic matter. Trace metal analysis shows significant but little participation of zinc, copper, nickel, iron and barium in water quality. The baseline developed and the data obtained will be useful for the water quality analysis after post-plant operation in this region.

**Keywords:** Water, JNPP Region, Physico-chemical parameters, Multivariate Statistics, Baseline.

## Introduction

Safe water is a basic human right and pre-condition for health and development, yet it is still denied to millions of people of the developing world. Poor sanitation and hygiene coupled with insufficient safe water cause water-related diseases leading to 3.4 million deaths per year and most of them are children<sup>21,23</sup>. India in 1974 enacted 'The Water Act' for prevention and control of water pollution to maintain and restore purity of water in the country. The act was further amended in 1992 and 2003. Currently, India's environment has become fragile and is of concern because of increasing industrialization, urbanization and growth in population<sup>9</sup>. Water quality expresses the suitability of water to sustain

various uses and processes. Every use or process requires certain physical, chemical and biological characteristics of water. Physical and chemical parameters of water are easily defined and hence, criteria set for water quality are largely based on physical and chemical conditions of the water. Biological methods of analyzing water quality are based on a diversity index derived from information theory. These indices express the relative importance of species, also they are dimensionless and independent of the sample size collected.

Once the water gets contaminated, it is difficult to restore its quality. Consequently, directly or indirectly everyone gets affected. Heavy metal contamination is a major problem in several communities and agricultural areas. Commercial agrochemicals, sewage water and industrial wastewater are the measured sources of heavy metal contamination<sup>15,16,25</sup>. The contamination in an aquatic community is of major concern because of its toxicity, abundance and persistence in the environment. This may contaminate the aquatic ecosystem or public health<sup>4,22</sup>. Thus the analysis of water quality is important to preserve the environmental system.

The application of basic and multivariate statistical methods including Cluster analysis (CA), Principal Component Analysis (PCA), Factor Analysis (FA) and Water Quality Index (WQI) for the investigation of water quality data are widely found in literature<sup>2,3,8,24,26</sup>. Government has responded to the water findings by implementing required appropriate action plans at diverse locations<sup>6</sup>. Hence it is important to provide the detailed composition of water parameters to help the local environmental policymakers.

## Study area

Jaitapur is a small village situated in the Rajapur Tehsil of Ratnagiri District, Maharashtra. It lies on the Arabian Sea coast. Nuclear Power Corporation of India Limited (NPCIL) proposed a Nuclear Power Plant with a 9900 MW capacity near Jaitapur. This project is located at 16.55° N; 73.35° E, a part of Konkan in the Western Ghats of Maharashtra. The issue was highlighted by different non-governmental organizations because of the adverse effects of radiation and different types of pollution. Also, many other industries like thermal power, mining of aluminium etc. are being constructed in this Konkan region. This Konkan region is famous for mango production and export especially



# Green synthesis of magnetite nanoparticles ( $\text{Fe}_3\text{O}_4$ NPs) using *Acacia concinna* fruit extract and their antibacterial activity

Shubhangi Mane-Gavade, Arihant Malgave, Gurunath Nikam, Amruta Koli, Amit Supale, and Sandip Sabale\*

This paper describes green, simple, and efficient method for the synthesis of magnetite nanoparticles ( $\text{Fe}_3\text{O}_4$  NPs) using *Acacia concinna* fruit extract for the first time. *A. concinna* fruit extract is used as reducing and stabilizing agent. Reduction of  $\text{Fe}^{3+}$  ions by *A. concinna* fruit extract is examined by UV-visible absorption spectra (UV-Vis-NIR). To recognize the functional group responsible for  $\text{Fe}_3\text{O}_4$ , the NPs are characterized by Fourier transform infra-red spectroscopy (FTIR). The structural analysis of  $\text{Fe}_3\text{O}_4$  NPs is done by X-ray diffraction (XRD) which confirms cubic spinel structure and the average crystallite size of obtained NPs is found to be 28 nm. The morphological studies of  $\text{Fe}_3\text{O}_4$  NPs are done by scanning electron microscope (SEM) which depicts the quasi-spherical morphology. The green synthesized  $\text{Fe}_3\text{O}_4$  NPs shows distinctive antibacterial activities against gram-negative *E. coli* and *Pseudomonas aeruginosa* microorganism which confirms its potential in biomedical applications.

## 1. Introduction

Magnetic nanoparticles (MNPs) have been attracting much attention because of their probable applications either as photocatalysis, ferro fluid technology, drug delivery, pigment, magnetic storage, magnetic ink printing, microwave absorption, biosensors, bio-separation, and in vivo drug delivery.<sup>[1,2]</sup> Particularly, magnetite nanoparticles ( $\text{Fe}_3\text{O}_4$  NPs) have attracted enormous interest, due to their unique magnetic properties, high electrical resistivity, and high chemical stability. It is often known that the activity of  $\text{Fe}_3\text{O}_4$  NPs strongly depends on their size, shape, and crystal phase.<sup>[3]</sup> Generally, the shape has a huge impact on the resulting properties of  $\text{Fe}_3\text{O}_4$  NPs and their potential applications.

S. Mane-Gavade, A. Malgave, G. Nikam, A. Koli, S. Sabale  
P. G. Department of Chemistry  
Jaysingpur College  
Jaysingpur, Maharashtra 416101, India  
E-mail: srsabale@gmail.com

A. Supale  
P. G. Department of Chemistry  
Patangrao Kadam Mahavidyalaya  
Sangli, Maharashtra 416416, India

The ORCID identification number(s) for the author(s) of this article can be found under <https://doi.org/10.1002/masy.202100140>

DOI: 10.1002/masy.202100140

These potential applications of  $\text{Fe}_3\text{O}_4$  NPs have inspired the fast development of various synthetic techniques such as coprecipitation, hydrothermal treatment, spray pyrolysis, ultrasound irradiation, microwave-assisted method, and solvothermal method.<sup>[4,5]</sup> While, most of these methods rely on the use of toxic reducing agents and special equipment which make them less eco-friendly and costly. Hence, there is urgent need to develop environmentally benign methods, where, natural products could be used that are biocompatible, low cost, and easily available and one such method is the green synthesis.<sup>[6]</sup> It makes use of plant extracts that acts as an efficient reducing and capping agent in  $\text{Fe}_3\text{O}_4$  NPs synthesis. It is economic and valuable alternative with toxic free approach.<sup>[7]</sup> Many researchers reported the synthesis

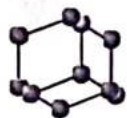
of  $\text{Fe}_3\text{O}_4$  NPs using *Artemisia annua*,<sup>[8]</sup> leaf extract of *Perilla frutescens*,<sup>[9]</sup> *Tridax procumbens*,<sup>[10]</sup> and *Caricaya papaya*,<sup>[11]</sup> peel extract of *plantain*,<sup>[12]</sup> and also seed extract of grape *proanthocyanidin*.<sup>[13]</sup> However, no literature reports are available for the synthesis of  $\text{Fe}_3\text{O}_4$  NPs using aqueous fruit extract of *Acacia concinna*.

In the present work, we report simple green route for the synthesis of magnetite NPs using *A. concinna* fruit extract. The phytochemicals present in *A. concinna* fruit extract are not only responsible for the formation of  $\text{Fe}_3\text{O}_4$  NPs but also act as capping agent for  $\text{Fe}_3\text{O}_4$  NPs. *A. concinna* is relatively large genus of plants belonging to *fabaceae* family.<sup>[14]</sup> The synthesized  $\text{Fe}_3\text{O}_4$  NPs were characterized using different characterization techniques and tested against pathogenic microorganisms.

## 2. Result and Discussion

### 2.1. Morphological and Structural Properties of $\text{Fe}_3\text{O}_4$ NPs

Scanning electron microscope (SEM) was used to examine the surface morphology and structure obtained  $\text{Fe}_3\text{O}_4$  NPs. Figure 1A shows representative SEM images of  $\text{Fe}_3\text{O}_4$  NPs produced by *A. concinna* fruit extracts during the biosynthesis reaction. The morphology observed was quasi-spherical and several agglomerates can be appreciated. Various studies describe this agglomeration as a steric effect caused by the interaction of the active sites of the



## Role of Nutrition in COVID-19: Present Knowledge and Future Guidelines



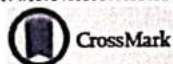
Maruti Jayram Dhanavade<sup>1,\*</sup> and Kailas Dashrath Sonawane<sup>2,3,\*</sup>

<sup>1</sup>Department of Microbiology, Bharati Vidyapeeth's Dr. Patangrao Kadam Mahavidyalaya, Sangli 416416, Maharashtra, India; <sup>2</sup>Department of Biochemistry, Shivaji University, Kolhapur, Maharashtra 416004, India; <sup>3</sup>Department of Microbiology, Shivaji University, Kolhapur, Maharashtra 416004, India

### ARTICLE HISTORY

Received: December 01, 2021  
Revised: January 16, 2022  
Accepted: January 30, 2022

DOI:  
10.2174/1573401318666220324115443



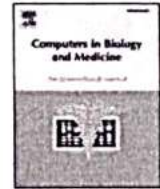
COVID-19 pandemic has become a serious threat to human beings, which is badly affecting the lives of mankind. The causative agent of COVID-19 is a novel coronavirus (SARS-CoV-2) that causes severe acute respiratory syndrome. The COVID-19 infection has been transmitted from animals to humans, and now it has spread astoundingly worldwide. In a severe case of COVID-19 disease, atypical pneumonia leads to the death of a diseased person. Some risk factors associated with COVID-19 include older age, smoking, cardiovascular disease (CD), obesity, respiratory diseases (RD), and a higher Sequential Organ Failure Assessment score. Due to the unavailability of effective drugs against COVID-19, people have been forced to implement strict regulations, including social distancing and lockdown. These restrictions have affected human populations in various aspects, viz., psychological, social, economic, etc. Although few vaccines have been developed, such as covishield, sputnik, and covaxin, etc., still the question remains about their efficacy and how to prevent re-infection among fully vaccinated people. However, several reports suggested that fully vaccinated individuals also get infected by mutated strains of SARS-CoV-2, and developing disease with less severity [1]. Few drugs like chloroquine, hydroxychloroquine, favipiravir, nafamostat camostat, remdesivir, etc., were used for COVID-19 treatment, but still, these drugs could not be the final solution against COVID-19 [2].

Structural bioinformatics studies would play an essential role in understanding the basic mechanism behind using few specific drug in COVID-19 [3]. However, we are still unaware about the exact role of nutrition and its modulation on the epidemiology of COVID-19 disease. Hence, in the present context, the evaluation of the relation between nutrition and the COVID-19 pandemic has been done. While searching the solution to COVID-19, it has been suggested that the nutritional status of an individual may alter the immune system positively or negatively; hence it has a big role to play in the modulation of SARS-CoV-2 infection [4].

Due to the lockdown during COVID-19, the eating habits of people have changed, which has led to the weakening of the immune system, and because of that, people may suffer from chronic disease in the future [5]. A balanced diet can boost the immune system, which will help to fight against many types of infections, including SARS-CoV-2, and live a healthy life. Another major aspect that is being ignored during this COVID-19 pandemic is that due to strict regulations, people have been quarantined to protect themselves from SARS-CoV-2 infection. This has changed the eating habits and daily routine of people, which could result in increased energy intake by consuming large amounts of fats, carbohydrates, and proteins. This high energy intake could have serious effects on some disease conditions like diabetes, heart disease, kidney disease, as well as COVID-19. Hence, there is an urge to shift our focus towards food intake that will play a significant role in keeping us healthy and functioning normally [6]. It has been strongly proposed that reduced obesity could be very helpful to minimize the chances of type 2 diabetes as well as severe COVID-19 disease [7]. Vitamin C is one of the best nutrients which can help to improve the immune system of an individual [8]. The change in nutrient supplements and their effects on the immune system in different age groups must be well understood during and after COVID-19 [9]. Importantly, it has been directed that minerals, vitamins C, A, D, and zinc play crucial roles in boosting the immune system during COVID-19. In viral, bacterial, fungal, and parasitic infections, the host's immune system is important for the protection and fight against these pathogens. The quick action of the immune system against foreign enemies can increase the metabolic rate; hence there is a requirement of good energy sources for the biosynthesis of regulatory molecules. In such circumstances, vitamins such as folate, A, B6, B12, C, D, and E, as well as trace minerals such as copper, iron, selenium, and zinc, have been found to play important roles in supporting the immune system and reducing infection risks. All these nutrients could play important role in supporting the antiviral and antibacterial defence system. Similarly, the gut microbiota could also be critical for regulating the host immune system [9, 10].

The plant-based food materials have been found to enhance the immunity against COVID-19 in all age groups [11]. Several plant-based food items have been shown to boost intestinal beneficial bacteria, which contributes to an immune system that is

\*Address correspondence to these authors at the Department of Microbiology, Bharati Vidyapeeth's Dr. Patangrao Kadam Mahavidyalaya, Sangli 416416, Maharashtra, India; Tell: +917071861212; E-mail: maruti.d@gmail.com  
Department of Biochemistry, Shivaji University Kolhapur, Maharashtra 416004, India; Tell: +919881320719; E-mail: kds\_biochem@unishivaji.ac.in



## Structural significance of Nephrylsin from *Streptococcus suis* GZ1 in the degradation of A $\beta$ peptides, a causative agent in Alzheimer's disease

Subodh Kamble<sup>a</sup>, Sagar Barale<sup>b</sup>, Maruti Dhanavade<sup>c</sup>, Kailas Sonawane<sup>a,b,\*</sup>

<sup>a</sup> Structural Bioinformatics Unit, Department of Biochemistry, Shivaji University, Kolhapur, 416004, M.S., India

<sup>b</sup> Department of Microbiology, Shivaji University, Kolhapur, 416004, M.S., India

<sup>c</sup> Department of Microbiology, Bharati Vidyapeeth's Dr. Patangrao Kadam Mahavidyalaya Sangli, Pin-416416, India

### ARTICLE INFO

#### Keywords:

Alzheimer's disease (AD)  
A $\beta$  plaque degradation  
Nephrylsin  
*Streptococcus suis* GZ1, homology modeling  
Molecular docking  
MD simulation

### ABSTRACT

Alzheimer's disease (AD) is a progressive brain disorder. The accumulation of amyloid beta (A $\beta$ ) peptides in the human brain leads to AD. The cleavage of A $\beta$  peptides by several enzymes is being considered as an essential aspect in the treatment of AD. Nephrylsin (NEP) is an important enzyme that clears the A $\beta$  plaques in the human brain. The human NEP activity has been found reduced due to mutations in NEP and the presence of inhibitors. However, the role of NEP in the degradation of A $\beta$  peptides in detail at the molecular level is not yet clear. Hence, in the present study, we have investigated the structural significance of NEP from the bacterial source *Streptococcus suis* GZ1 using various bioinformatics approaches. The homology modelling technique was used to predict the three-dimensional structure of NEP. Further, molecular dynamic (MD) simulated model of NEP was docked with A $\beta$  peptide. Analysis of MD simulated docked complex showed that the wild-type NEP-A $\beta$ -peptide complex is more stable as compared to mutant complex. Hydrogen bonding interactions between NEP with Zn<sup>2+</sup> and A $\beta$  peptide confirm the degradation of the A $\beta$  peptide. The molecular docking and MD simulation results revealed that the active site residue Glu-538 of bacterial NEP along with Zn<sup>2+</sup> interact with His-13 of A $\beta$  peptide. This stable interaction confirms the involvement of NEP with Glu-538 in the degradation of the A $\beta$  peptide. The other residues such as Glu203, Ser537, Gly140, Val587, and Val536 could also play an important role in the cleavage of A $\beta$  peptide in between Asp1-Ala2, Arg5-His6, Val18-Phe19, Gly9-Tyr10, and Arg5-His6. Hence, the predicted model of the NEP enzyme of *Streptococcus suis* GZ1 could be useful to understand the A $\beta$  peptide degradation in detail at the molecular level. The information obtained from this study would be helpful in designing new lead molecules for the effective treatment of AD.

### 1. Introduction

Alzheimer's disease (AD) is a progressive neurodegenerative disorder that causes an irreversible and gradual decline of memory, language skills, perception of time and space, and the ability to care for oneself. Amyloid plaque formation is a pathological hallmark in AD [1,2]. The A $\beta$ <sub>1-40</sub> and A $\beta$ <sub>1-42</sub> peptides are the main constituents of amyloid plaques in AD [3-5]. The familial autosomal dominant (FAD) mutations and improper proteolytic degradation increases A $\beta$ <sub>1-42</sub> and A $\beta$ <sub>1-40</sub> peptides deposition in the brain [6]. In the human brain, the formation of A $\beta$  peptide is a continuous process, and it is estimated to have a physiological production rate of 7.6% per hour [7]. The enzymes such as Insulin Degrading Enzyme (IDE), Human Endothelin Converting Enzymes (hECE), Angiotensin Converting Enzyme (ACE), Cathepsin B, Cathepsin

D, and Nephrylsin (NEP) present in the human brain are known to play an important role in A $\beta$  peptide clearance [8-12]. Similarly, in a recent review role of amyloid beta peptide-degrading microbial enzymes and their implication in drug designing has been discussed [13].

The NEP is also known as neutral endopeptidase-24.11 (E.C.3.4.24.11), Enkephalinase, neutrophil cluster-differentiation antigen 10, or common acute lymphoblastic leukemia antigen [14]. The NEP is a 90-110 kDa plasma membrane glycoprotein of the neutral zinc metalloendopeptidase family [15]. In the human brain, NEP is expressed at pre- and post-synaptic membranes and is involved in the regulation of neuropeptide signalling. It is also expressed in the tunica media and endothelium of cortical and leptomeningeal blood vessels, where it is involved in the regulation of vascular tone. *In-vivo* assay with radio labelled A $\beta$  peptide reported the involvement of NEP enzyme in the

\* Corresponding author. Structural Bioinformatics Unit, Department of Biochemistry, Shivaji University, Kolhapur, 416 004, Maharashtra (M.S.), India.  
E-mail address: [kds\\_biochem@unishivaji.ac.in](mailto:kds_biochem@unishivaji.ac.in) (K. Sonawane).



## Article

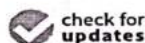
# Modifying Thermostability and Reusability of Hyperthermophilic Mannanase by Immobilization on Glutaraldehyde Cross-Linked Chitosan Beads

Beenish Sadaqat <sup>1,2</sup>, Chong Sha <sup>2</sup>, Mudasir Ahmad Dar <sup>2</sup>, Maruti J. Dhanavade <sup>3</sup>, Kailas D. Sonawane <sup>4</sup>, Hassan Mohamed <sup>1,5</sup>, Weilan Shao <sup>2,\*</sup> and Yuanda Song <sup>1,\*</sup>

- <sup>1</sup> Colin Ratledge Center for Microbial Lipids, School of Agriculture Engineering and Food Science, Shandong University of Technology, Zibo 255049, China; beenish@sdu.edu.cn (B.S.); hassanmohamed85@azhar.edu.eg (H.M.)
- <sup>2</sup> School of the Environment and Safety Engineering, Biofuels Institute, Jiangsu University, Zhenjiang 212013, China; jnshachong@163.com (C.S.); mudasir.dar@unipune.ac.in (M.A.D.)
- <sup>3</sup> Department of Microbiology, Bharati Vidyapeeth's Dr Patangrao Kadam Mahavidyalaya College, Sangli 416416, India; marutijd@gmail.com
- <sup>4</sup> Structural Bioinformatics Unit, Department of Biochemistry, Shivaji University, Kolhapur 416004, India; kds\_biochem@unishivaji.ac.in
- <sup>5</sup> Department of Botany and Microbiology, Faculty of Science, Al-Azhar University, Assiut 71524, Egypt
- \* Correspondence: weilanshao@foxmail.com (W.S.); ysong@sdu.edu.cn (Y.S.)

**Abstract:** In the current study, the purified  $\beta$ -mannanase (Man/Cel5B) from *Thermotoga maritima* was immobilized on glutaraldehyde cross-linked chitosan beads. The immobilization of Man/Cel5B on chitosan beads was confirmed by Fourier-transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD) analysis. After immobilization, the protein loading efficiency and immobilization yield were found to be 73.3% and 71.8%, respectively. The optimum pH for both free and immobilized enzymes was found to be pH 5.5. However, the optimum temperature of immobilized Man/Cel5B increased by 10 °C, from 85 °C (free Man/Cel5B) to 95 °C (Immobilized). The half-life of free and immobilized enzymes was found to be 7 h and 9 h, respectively, at 85 °C owing to the higher thermostability of immobilized Man/Cel5B. The increase in thermostability was also demonstrated by an increase in the energy of deactivation (209 kJmol<sup>-1</sup>) for immobilized enzyme compared to its native form (92 kJmol<sup>-1</sup>), at 85 °C. Furthermore, the immobilized Man/Cel5B displayed good operational stability as it retained 54% of its original activity after 15 repeated catalytic reactions concerning its free form.

**Keywords:**  $\beta$ -mannanase; docking; hyperthermostable; kinetics



**Citation:** Sadaqat, B.; Sha, C.; Dar, M.A.; Dhanavade, M.J.; Sonawane, K.D.; Mohamed, H.; Shao, W.; Song, Y. Modifying Thermostability and Reusability of Hyperthermophilic Mannanase by Immobilization on Glutaraldehyde Cross-Linked Chitosan Beads. *Biomolecules* **2022**, *12*, 999. <https://doi.org/10.3390/biom12070999>

Academic Editor: Tigran Chalikian

Received: 23 June 2022

Accepted: 12 July 2022

Published: 18 July 2022

**Publisher's Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

Mannans are an integral part of hemicellulose and are predominantly found in the soft woods, plant endosperms, seeds, and vacuoles of a wide variety of plants [1–3]. Mannans are also present as glycoproteins in the cell walls of some yeasts, fungi, and bacteria [4].  $\beta$ -1,4-mannanase (mannan mannohydrolase, EC 3.2.1.78) is an endo-acting hydrolase that randomly cleaves the  $\beta$ -1,4-mannosidic linkages in the main chain of mannans (linear mannan, galactomannan, glucomannan, and galactoglucomannan), therefore producing manno-oligosaccharides (MOS) of various lengths [5].  $\beta$ -mannanase has wide industrial applications as it is used for the production of partially hydrolyzed guar gum, MOS, fruit juice clarification, paper/pulp bio-bleaching, synthesis of detergents, amelioration of animal or poultry feed, and saccharification of biomass [6,7].

Despite the versatility of  $\beta$ -mannanase, the use of these enzymes in soluble form at the industrial scale has some limitations including low stability, unmanageable recovery and reuse, short shelf life, difficulty in handling, and loss of activity at prolonged operational





Contents lists available at ScienceDirect

Life Sciences

journal homepage: [www.elsevier.com/locate/lifescie](http://www.elsevier.com/locate/lifescie)

## Exploring bioactive peptides as potential therapeutic and biotechnology treasures: A contemporary perspective

Prasanna J. Patil<sup>a,b</sup>, Shubham S. Sutar<sup>c</sup>, Muhammad Usman<sup>a,b</sup>, Devashree N. Patil<sup>c</sup>, Maruti J. Dhanavade<sup>d</sup>, Qayyum Shehzad<sup>e</sup>, Arshad Mehmood<sup>a,b,f</sup>, Haroon Shah<sup>a,b</sup>, Chao Teng<sup>a,b,f</sup>, Chengnan Zhang<sup>a,b,f,\*</sup>, Xiuting Li<sup>a,b,f,\*</sup>

<sup>a</sup> Beijing Advanced Innovation Center for Food Nutrition and Human Health, Beijing Technology and Business University, Beijing 100048, China

<sup>b</sup> School of Food and Health, Beijing Technology and Business University, No. 11, Fucheng Road, Beijing 100048, China

<sup>c</sup> Department of Biotechnology, Shivaji University, Vidyanagar, Kolhapur, Maharashtra 416004, India

<sup>d</sup> Department of Microbiology, Bharati Vidyapeeth's Dr. Patangrao Kadam Mahavidyalaya, Sangli, Maharashtra 416416, India

<sup>e</sup> National Engineering Laboratory for Agri-Product Quality Traceability, Beijing Technology and Business University, Beijing 100048, China

<sup>f</sup> Beijing Engineering and Technology Research Center of Food Additives, School of Food and Chemical Technology, Beijing Technology and Business University, Beijing 100048, China

### ARTICLE INFO

#### Keywords:

Bioactive peptides  
Aptamers  
Anti-CoVID-19  
Anti-cancer  
Neuroprotection  
Next-generation approaches

### ABSTRACT

In preceding years, bioactive peptides (BAPs) have piqued escalating attention owing to their multitudinous biological features. To date, many potential BAPs exhibiting anti-cancer activities have been documented; yet, obstacles such as their safety profiles and consumer acceptance continue to exist. Moreover, BAPs have been discovered to facilitate the suppression of Coronavirus Disease 2019 (CoVID-19) and maybe ideal for treating the CoVID-19 infection, as stated by published experimental findings, but their widespread knowledge is scarce. Likewise, there is a cornucopia of BAPs possessing neuroprotective effects that mend neurodegenerative diseases (NDs) by regulating gut microbiota, but they remain a subject of research interest. Additionally, a plethora of researchers have attempted next-generation approaches based on BAPs, but they need scientific attention. The

**Abbreviations:** AAs, Amino acids; A $\beta$ , Amyloid  $\beta$ ; ACBPs, Anticancer bioactive peptides; AChE, Acetylcholinesterase; AD, Alzheimer's disease; ADNF, Activity-dependent neurotrophic factor; AEGIS-SELEX, Artificially expanded genetic information system-SELEX; AFM-SELEX, Atomic force microscopy-SELEX; Aib,  $\alpha$ -Aminoisobutyric acid; AIDS, ACE-2-interacting Domain of SARS-CoV-2; ALS, Amyotrophic lateral sclerosis; AP-1, Activator protein 1; AQ, Aquashine; BAPs, Bioactive peptides; BACE1, Beta-site amyloid precursor protein (APP) cleaving enzyme-1; Bax, B-cell lymphoma protein 2-associated X; BBB, Blood-brain barrier; BChE, Butyrylcholinesterase; Bcl-2, B-cell lymphoma 2; BCM-7, Betacasmorphin-7; BMP-2, Bone morphogenic protein-2; BR, Brightening; CAS, Catalytic anionic site; Cdk5, Cyclin-dependent kinase 5; CE-SELEX, Capillary electrophoresis-SELEX; CIP, Cdk5 inhibitory peptide; CNT-PLLA, Carbon nanotube-poly-L-lactic acid; CoVID-19, Coronavirus disease 2019; CRF, Corticotrophin-releasing factor; CuAAC, Copper(I)-catalyzed alkyne-azide cycloaddition; OGLcNAc, O-linked N-acetyl-D-glucosamine; cyO8, Cycloviolacin O8; E-PB, Electrochemical peptide-based; EX-4, Exendin-4; FDM, Fused deposition modelling; GAPDH, Glyceraldehyde-3-phosphate dehydrogenase; GLP-1R, Glucagon-like peptide 1 receptor; hACE2, Human angiotensin-converting enzyme 2; HAH, Hyaluronate-alginate hybrid; hCMCs, Human circulating multipotent cells; HD, Huntington's disease; HDMP, Human defensin-6 mimic peptide; hMSCs, Human mesenchymal stem cells; HTT, Huntingtin; IFN- $\alpha$ , Interferon-alpha; IL-6, Interleukin 6; IP-SELEX, Immunoprecipitation-coupled-SELEX; KTN, Keratin; LDH, Lactate dehydrogenase; LTM, Long-term memory; LTP, Long-term potentiation; MB, Methylene blue; MC, Methylcellulose; Mcl-1, Myeloid cell leukemia-1; MERS-CoV, Middle East respiratory syndrome coronavirus; mHTT, Mutant huntingtin; MPP<sup>+</sup>, 1-methyl-4-phenylpyridinium; MPTP, 1-Methyl-4-phenyl-1,2,3,6-tetrahydropyridine; MTT, 3-(4,5-dimethyl thiazolyl)-2,5-diphenyl-tetrazolium bromide; ND, Neurodegenerative disease; NF- $\kappa$ B, Nuclear factor kappa B; NK, Nattokinase; OBP, Odorant-binding protein; OGP, Osteogenic growth peptide; PA, Peptide amphiphile; PAC1, Pituitary adenylate cyclase-activating polypeptide type I receptor; PARP, Poly (ADP-ribose) polymerase; PCNA, Proliferating cell nuclear antigen; PD, Parkinson's disease; PEG, Polyethylene glycol; PEGDA, Polyethylene glycol diacrylate; PEU, Poly(ester urea); pI, Isoelectric point; PLLD, Polylysine dendrimers; PLN, Phospholamban; PEOGMA-PHPMA, Poly(oligo(ethylene glycol) methyl ether methacrylate)-Poly(2-hydroxypropyl methacrylate); PSA, Prostate-specific antigen; PSC, Peptide sesame cake; PTMs, Post-translational modifications; RAFT, Reversible addition-fragmentation chain transfer; RBD, Receptor-binding domain; RBM, Receptor-binding motif; ROS, Reactive oxygen species; SARS-CoV-2, Severe acute respiratory syndrome coronavirus 2; SELEX, Systematic evolution of ligands by the exponential enrichment; SF, Silk fibroin; SHR, Spontaneously hypertensive rat; SIRT6, Sirtuin 6; TAT, Cell penetrating peptide; TNF $\alpha$ , Tumor necrosis factor  $\alpha$ ; TP, Tyrosine phosphatase; TPE, Tetraphenylethene; TUNEL, Terminal deoxynucleotidyl transferase dUTP nick end labelling; VEGF, Vascular endothelial growth factor; VIP, Vasoactive intestinal peptide; 3D, Three-dimensional.

\* Corresponding authors at: Beijing Technology and Business University, No. 11 Fucheng Street, Haidian District, Beijing 100084, China.

E-mail addresses: [zhangcn@btbu.edu.cn](mailto:zhangcn@btbu.edu.cn) (C. Zhang), [lixt@btbu.edu.cn](mailto:lixt@btbu.edu.cn) (X. Li).

<https://doi.org/10.1016/j.lfs.2022.120637>

Received 6 January 2022; Received in revised form 2 May 2022; Accepted 9 May 2022

Available online 11 May 2022

0024-3205/© 2022 Published by Elsevier Inc.

# Evaluation of Industrial Development in Cottage and Village Industries of Thane District

Dr. Nitin Vinayak Gaikwad,

Assistant Professor, Bharati Vidyapeeth's Dr. Patangrao Kadam Mahavidyalaya, Sangli (India)

## **ABSTRACT**

Thane is the third most industrialized quarter in the state of Maharashtra. There are 1548 large and medium scale and 18480 small scale diligence in the quarter. The main products of this diligence are medicines, Fabrics, Plastics, Rubber, steel medicinals, engineering, diseases, electronics, and chemicals. The Thane-Belapur-Kalyan artificial belt is the center of largely sophisticated ultramodern diligence. In Ambernath, Bhiwandi, Belapur, Tarapur, and Murbad these are nearly 4000 diligence which contributes towards the industrialization of the quarter manufacture of Rice manufactories at Digheshi (Bhiwandi) and vada, Khandsari at Palghar, Village diligence at Bhiwandi and Chinchani, Bricks and crockery making at Palghar. Besides the above-mentioned diligence fishery and forestry were also carried out on a Co-operatives base. All these artificial Co-operatives societies were formed by Workers, crafters, and occasionally by professed workers and comported of embroiderer's tanners, carpenters, blacksmiths, essence workers, potters, rice pounders, and others. It'll be seen from the above that progress made by the Co-operatives societies in the field of manufacturing and processing was veritably limited in Thane quarter and artificial Cooperation had touched only much small diligence similar as forestry, fishery, vill diligence, rice shop, engineering, and leather goods, etc. This Paper concentrated on geographical analysis of the evaluation and development of assiduity in the Thane quarter.

**KEYWORDS:** Talukawise distribution of cottage and village industries in Thane district, Government policies, and industrial development in Thane district.

## **Introduction:**

The growth and industries depend upon several factors viz. Availability of various resources, climate, transport network, workers, market facilities, capital, and power, Besides these factors efforts made by either individual entrepreneurs or co-operative societies or industrial estate or government, prove significant for the growth of industries in any region. Efforts of these four agencies i.e., individual entrepreneurs, cooperative societies, Industrial estates, and Government create pre-condition and infra-structure which are essential for industrialization.

These efforts though basically essential are not to be necessarily conducive to proper regional development. These efforts if done on a good scientific-based then proper utilization of resources is a possibility while planning a region industrially. It is necessary to see whether the contemporary efforts put in by these agencies are competent to use the region's resources efficiently and optimally. Therefore, our aim here is to examine the extent of the efforts put in by the individual entrepreneurs. Co-operative societies, Industrial estates, and government in the Thane district for the development of industries.

## **Database and Methodology:**

The primary and secondary data will be used for the study. Particularly the period of study will be chosen from 2001 to 2012 for the collection of primary data, special questionnaires will be used. The broad picture of the present pattern of land utilization of industrial cropping pattern of production of industrial crops will be prepared with the help of secondary data obtained from Socio-Economic review, District statistical abstract and District census handbook, etc.

Data regarding the number of Cottage and Village industries, capital investment and working capital capacity of utilization, Value of finished products or its market value and its profit will be considered some data will be obtained from District industrial center (DIC) and field survey, a special questionnaire has been used to collect data. Data collected through primary and secondary sources will be proceeded and represented by statistical data and cartographic techniques.

## **Talukawise Distribution of Cottage and Village Industries in**

### **Thane District:**

In Thane district total cottage and village, the industry was 246 out of them the highest share of cottage and village industry was found in Bhiwandi Tahsil 49 means 19.92% followed by Vada 48 (19.51%) Whereas the lowest share was found in Talasari and Vikramgad Tahsil there is only one each cottage and village industry was found, and the percentage of industries was (0.41%). Palghar and Shahapur Tahsil also have a maximum number of cottage and village industries the share of Palghar Tahsil was 13.82% and Shahapur Tahsil share was 13.01% during the period under investigation.