Journal of Environmental Science & Engineering (JESE)

About the Journal

Started in 1958, Journal of Environmental Science & Engineering (JESE) is a peer reviewed quarterly journal published by the National Environmental Engineering Research Institute (NEERI, CSIR), Nagpur reporting various significant achievements in the field of environmental science and engineering, according to the R&D thrust areas of the Institute. The journal is providing communication links among the members of the scientific community engaged in research in India and abroad covering all the major aspects of environmental science and engineering.

Aims and Scope

The scope of this journal covers Environmental Science and Engineering and the related areas. The journal intends to timely disseminate information related to monitoring of the environmental status across the country and abroad, innovative and effective S&T solutions to environmental and natural resource problems, significant R&D activities in the field of environmental science and technology, environmentally sound technologies and policy analysis. The journal aims at publishing both review and research articles in the field of environmental science and engineering. Case studies and short communications are also published to inform about the hazards and risks likely to occur to the people and environment due to certain materials, and the ways of controlling these hazards and associated risks. Various topics covered in the journal include: air quality monitoring, modeling and management; air pollution control; source management and apportionment studies; carrying capacity based developmental planning; soil and water chemistry, monitoring and management of land degradation; river and lake ecosystem studies; application of fly ash, sewage, sludge and mine tailing on land; ecological approaches to improve ecological and socio-economic values of land-use systems; integrated natural resource management; conservation and sustainable management of under ground biodiversity, remote sensing applications in environmental geo-science; ground water and rain water harvesting; water and waste water treatment; solid and hazardous waste management; eco-friendly technologies; waste land management; biodiversity assessment; biogeochemistry of rivers and estuaries; pollution chemistry, particularly metal speciation and bioavailability in water and soil systems; PAHs and volatile organics in atmosphere; environmental analytical methodologies; monitoring and modeling of urban noise; environmental impact and risk assessment studies; environmental audit studies; chemical process simulation and development; environmental policies; bioremediation and biodegradation studies; environmental biotechnology and genomics studies; research on environmental materials, etc.

The journal publishes high-impact contributions on:

1. Environmental monitoring
2. Environmental biotechnology
3. Environmental systems design modelling and optimisation
4. Environmental impact and risk assessment
5. Solid and hazardous waste management
6. Policy analysis and planning

The Vision

Journal of Environmental Science & Engineering endeavors to become a leading medium for dissemination of scientific and technical information in environmental science and engineering

The Mission

To provide environmental scientific information with description of timely, contemporary advances in environmental science and engineering, and management for use in improving our environment

The *Journal of Environmental Science & Engineering* is published quarterly. The Institute assumes no responsibility for the statements and opinions advanced by contributors. The editorial staff in its work of examining papers received for publication is assisted, in an honorary capacity, by a large number of distinguished scientists. Communications regarding contributions for publication in the journal should be addressed to the Editor-in-chief, *Journal of Environmental Science & Engineering,* CSIR-National Environmental Engineering Research Institute, Nehru Marg, Nagpur – 440 020. All correspondence regarding reprints, journal copies, subscription renewals, claims for missing numbers and advertisements should be sent to the same address.

Annual Subscription (w.e.f. 1 January 2014) : Individual: Rs. 1000/- (Inland) $200 (Foreign) and Institutions & Organizations: Rs. 4000/- (Inland) $600(Foreign). The subscription proforma is placed at our website www.neeri.res.in. You may use the same proforma for placing your orders for subscription. You are requested to kindly send the same along with Demand Draft by post to Managing Editor, Journal of Environmental Science & Engineering, Waste Reprocessing Division, CSIR- National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur – 440 020. *The Demand Draft should be drawn in favour of Director, NEERI, Nagpur – 440 020.*

For further details, please write to: Dr. Sunil Kumar, Managing Editor, Journal of Environmental Science & Engineering, Waste Reprocessing Division, CSIR-National Environmental Engineering Research Institute (NEERI) Nehru Marg, Nagpur - 440 020;
Phone : + 91 712 - 2249748; Fax : + 91 712 - 2249900; E. mail : jese@neeri.res.in
Website : www.neeri.res.in / neerijese.org

Printed & Published by : Dr. Rakesh Kumar, Director, CSIR-NEERI on behalf of CSIR-National Environmental Engineering Research Institute, Nehru Marg, Nagpur – 440 020 (India)
Registered with Registration of Newspapers of India (Reg. No. 6465/59)
Printed at : Mudrashilpa Offset Printers, Bajaj Nagar, Nagpur.

Journal of Environmental Science & Engineering

(http://www.neeri.res.in) ISSN 0367-827 X

Volume 61 No. 2 April 2019

CONTENTS

Environmental System Design Modelling & Optimisation

* **Exploring the potential of biosorption of Chromium (VI) by novel biosorbents from *P. julifora* and *A. nilotica*** ... 678-695

Aswathy Udayan, Hephzibah Glory S. J., Mrudul Lalitya N., Mahalakshmi S., Praveen K. and Nidhin Sreekumar

Environmental Monitoring

* **Changes in Aerosol Concentrations During Quarantine in Lima Metropolitan Area, Peru** ... 696-700

Odon Sanchez-Ccoyllo, Jessica Arratea-Moran, Carol Ordonez-Aquino, Carmen Aquije-Dapozzo, Jacinto Vertiz-Osores, Luis Gamarra-Chavarry, Nelida Marín-Huachaca, Warren Reategui-Romero

* **Phytoremediation using *Salsola Baryosma* as a Halophyte Suitable for Domestic Wastewater Treatment South-east of Algeria** ... 701-707

Kaddour Zineb, Oucif Khaled Mohammed Tayeb and Abderrahmane Khechekhouche

Solid & Hazardous Waste Management

* **Environmental Impacts of COVID-19 with Special Reference to Plastic Waste - A Review** ... 708-713

P. D. Charan, Gautam Kumar Meghwanshi and Abhishek Vashishtha

* **Pectin-Based Composites for Energy and Environment** ... 714-724

Nair Sreecha Chandran, Sonia John, Sharrel Rebello, Reshmy R., Raveendran Sindhu, Ashok Pandey and Parameswaran Binod

* **Bioconversion of Low Cost Waste Material to Rhamnolipid using *Pseudomonas aeruginosa*** ... 725-735

Bhavana Pandey, S. K. Upadhyay and Lalit Kumar Singh

The journal is covered by the following leading abstracting, indexing and current awareness services:

- Chemical Abstracts Service
- Sci-Search – A Cited Reference Science Database
- Engineering Index
- Current Contents
- Research Alert
- Cambridge Scientific Abstracts
- INSPEC
- Biotechnology and Bioengineering Abstracts
- Biological Abstracts
- EMBASE
- Scopus
- IC Journals
- CAB Abstracts
- Elsevier Biobase -Current Awareness in Biological Sciences (CABS)
- Indian Science Abstracts
- BIOBASE
- BAILSTEIN
- IARAS
- Compendex
- ACM
- Ulrich's
- National Library of the Netherlands
- French National Library
- British Council Libraries
- German National Library of Science and Technology
- National Library

This issue is published in July 2022

J. Environ. Science & Engg. Vol. 61, No. 2, p. 678-695, April 2019

Exploring the potential of biosorption of Chromium (VI) by novel biosorbents from *P.julifora* and *A.nilotica*

[1]Aswathy Udayan, [2]Hephzibah Glory S J, [2]Mrudul Lalitya N, [2]Mahalakshmi S, [2]Praveen K, and [2,3]Nidhin Sreekumar*

The rapid growth of industries leads to environmental pollution by releasing toxic effluents into the water bodies. The presented study focuses on the alleviation of Cr(VI) from aqueous sources by novel biosorbents from indigenous and abundantly available biomass sources, namely *P.julifora* (Seemai karuvelam) and *A.nilotica* (Nattu karuvelam). In the presented work, leaf powders of *P.julifora* and *A.nilotica* were compared for the Cr(VI) adsorption capacity against pre-reported biosorbents from algal biomass (ABMP) and Neem (*A.indica*) leaf powder (NLP). Optimization of process parameters like contact time, pH and dosage, were carried out via Central Composite Design (RSM). The underlying biosorption mechanisms were studied using multiple (12) adsorption isotherms and kinetic models. The results showed that *A.nilotica* (Nattu karuvelam) leaf powder (NKLP) has an adsorption capacity (q) of 40mg/g over 23mg/g for Neem leaf powder and other biosorbents taken in this study under optimized conditions of pH 4.0 at 25°C. The isotherm studies revealed that the mechanism of adsorption for both NKLP and SKLP follows temperature-dependent multilayer biosorption (Dubinin– Radushkevich). Kinetic experiments reveal that NKLP follows pseudo-first-order kinetics and others follow Elovich kinetics. From this study, it was inferred that NKLP has good biosorption potential, in comparison with other biosorbents.

Key words: *Biosorption, A.indica, P. julifora, A.nilotica, chromium removal.*

1. INTRODUCTION

Chromium, a naturally occurring element that exists in two states, i.e. Cr(III) (trivalent chromium) and Cr(VI) (hexavalent chromium), the latter being more toxic and the focus of our study. Cr(VI) finds its industrial applications in the manufacture of steels and alloys, dyes, cooling towers, in tannery industries for leather manufacture and wood preservation (He et al., 2020). Industrial effluents contain high concentrations of Cr(VI) which poses a serious threat to humankind. Hexavalent chromium is identified as a "Human Carcinogen" in a health report released by the Environmental Protection Agency (EPA), USA in the public domain (Adeniji, 2004). The respiratory tract has a significant impact by Cr(VI) like, bronchitis with decreased pulmonary function, perforations and ulcerations of the septum. Chronic inhalation can lead to lung cancer and also a chance to damage the small capillaries in the kidney and intestine. Dermal exposure causes dermatitis and ulceration of the skin (Laxmi and Kaushik, 2020). Considering these factors, there is a constant threat to occupational health in industrial workers. Hence an efficient system for the successful abstraction of chromium from industrial wastewater is indeed necessary for the current scenario. The present study aims to develop a cheap, eco-friendly and economically viable method to alleviate Cr(VI) from industrial wastewater.

Much research has been explored for reducing the levels of Cr(VI) in industrial wastewater using chemicals, microbes and plants. Landfill, ion-exchange resins (or) Granular Activated Carbon (GAC) filters were some technologies to eliminate chromium (He et al., 2020). Adsorption was found out to be one of the effective methods as it is reversible and also that porous substances are better sorbents as increased surface area promotes sorption, sorbents like activated carbon, silica were expensive, and the elution of Cr (VI) from the polymer is proving to be difficult, and regeneration of polymer is costly. Chitosan, which is found to be economical, is the current technology being used in the process of treating industrial effluents with Cr (VI). These reasons contributed to the search for a stable adsorbent which is cheap, has the possibility of easy elution and can be disposed of without regeneration because of low cost. Natural products and wastes have the ability to adsorb heavy metals (Nakkeeran et al., 2018; Rangabhashiyam et al., 2016). As the name suggests, "bio" (of biological origin) and "sorption"(here to adsorb onto a surface). This led to "Biosorption", the application of biological sources to adsorb heavy metals, i.e., by rapid,

[1] Technology Development Cell, CSIR – National Environmental Engineering Research Institute, Nagpur, India
[2] Department of Biotechnology, School of Bio and Chemical Engineering, Kalasalingam Academy of Research and Education, Krishnankoil, Tamil Nadu, India
[3] Accubits Technologies Inc.
* Corresponding Author : Mail: nidhins10@gmail.com Ph: +91 9496 36 5797

J. Environ. Science & Engg. Vol. 61, No. 2, p. 696-700, April 2019

Changes in Aerosol Concentrations During Quarantine in Lima Metropolitan Area, Peru

ODÓN SÁNCHEZ-CCOYLLO[A*], JESSICA ARRATEA-MORÁN[A], CAROL ORDOÑEZ-AQUINO[B], CARMEN AQUIJE-DAPOZZO[A], JACINTO VERTIZ-OSORES[A], LUIS GAMARRA-CHAVARRY[A], NÉLIDA MARÍN-HUACHACA[C], WARREN REÁTEGUI-ROMERO[D]

The goal of this research was to assess the changes in aerosol PM_{10} and $PM_{2.5}$ concentrations for the time of the quarantine from March 16 to May 31, 2020 in Lima, Peru, by comparing with data sets from 2016 to 2019 for the same time-frame using the Mean Normalized Bias (MNB). This analysis was applied by selecting two monitoring stations namely Industrial Station and Traffic Station in the Lima Metropolitan Area (LMA) in Peru. The results revealed that during the lockdown the decrease of everyday mean concentrations of coarse (PM_{10}) and fine ($PM_{2.5}$) aerosol were approximately 53.6% and 32.2%, respectively in Industrial station. This is because during lockdown anthropogenic activities in Lima decreased aerosol emissions. Furthermore, in the Industrial Station, this decrease was significant as compared to the previous years, that is from 2016 to 2019. Moreover, a decrease of approximately 45.1% and 51.5% in coarse and fine particle concentrations were observed respectively. Thus, a significant decline in coarse and fine aerosol measured in 2020 contrasted to the earlier years in both Industrial and Traffic stations. Furthermore, the present study analyzed the correlation between climate variables and, aerosols, and deaths caused by COVID-19 from April 10 to May 31, 2020 in LMA. The Spearman correlation test for average daily relative humidity, daily air temperature, and average daily absolute humidity were significant with regard to the number of mortalities in LMA.

Keywords: Meteorological variables, particulate matter, COVID-19, Lima Metropolitan Area

1. Introduction :

In 2018 the annual $PM_{2.5}$ was 28 μg m^{-3} in Lima, which exceeded the World Health Organization Air Pollution Guideline (WHO AQG) annual mean of 10 μg m^{-3}. There is evidence to demonstrate the association between exposure to particulate matters in urban areas with respiratory Hadei *et al.* [2020] and cardiovascular diseases [Sun and Zhu, 2019]; [Miller and Newby, 2020]. For this reason, it is important to monitor the particulate matter, especially during the COVID-19 pandemic. Lockdown rules including remote work, decrease in public transport, and closure of international transport began in Peru on March 16, 2020. According to the Ministry of Health in Peru, the first COVID-19 related death in the country occurred on March 19, 2020. According to the Ministry of Health of Peru on October 8, 2020, Peru registered 33,098 deaths related to COVID-19. In addition, on October 12, 2020, Peru recorded the highest deaths per million people in entire South America [JHCRC, 2020]. Moreover, the amount of COVID-19 victims on September 8, 2020 was 838,614. Globally, Peru had the fifth highest quantity of COVID-19 cases after US, Brazil, India, and Russia, as on September 9, 2020 [JHCRC, 2020]. Others studies showed that during COVID-19 pandemic quarantine concentrations of coarse and fine aerosol decreased Marlier *et al.* [2020];Huang *et al.* [2020]; Collivignarelli *et al.* [2020]; Mendez *et al.* [2020]; Tobías et al. [2020]; Bolaño *et al.* [2020]. In addition, Kumar *et al.* [2020] investigated the relationship concerning COVID-19 and climate in Singapore, Tosepu *et al.* [2020] investigated the relationship amid meteorological conditions and daily COVID-19 pandemic in Jakarta, Indonesia, Islam *et al.* [2020] investigated the consequence of atmospheric aspects on COVID 19 circumstances in Bangladesh, and Ogaugwu *et al.* [2020] investigated the influence of climate on COVID-19 spread and death in Lagos, Nigeria. This investigation objective to calculate the changes in PM_{10} and $PM_{2.5}$ during

[a] Atmospheric Pollution Research Group, Escuela profesional de Ingeniería Ambiental, Universidad Nacional Tecnológica de Lima Sur. Sector 3, Grupo 1A 03-Cercado (Av.Central y Av.Bolivar), Lima 42, Lima, Peru; osanchez@untels.edu.pe (O.S-C); jessica.arrateam@gmail.com (J.A-M); caquije@untels.edu.pe (C.A-D); jvertiz@untels.edu.pe (J.V-O); lgamarra@untels.edu.pe (L.G-C).

[b] Escuela de Posgrado, Maestría en Meteorología Aplicada, Universidad Nacional Agraria La Molina, Lima, Peru. Av. La Molina s/n La Molina, Lima, Peru; ordonez.carol26@gmail.com

[c] Facultad de Ingeniería Ambiental, Universidad Nacional de Ingeniería. Av. Túpac Amaru 210, Lima 25, Lima, Peru; nmarin@uni.edu.pe

[d] Facultad de Ingeniería Química y Textil(FIQT), Universidad Nacional de Ingeniería(UNI). Av. Túpac Amaru 210, Lima 25, Lima, Peru; wreategui@uni.edu.pe

[*] Correspondence to Odón Sánchez-Ccoyllo (osanchez@untels.edu.pe)

J. Environ. Science & Engg. Vol. 61, No. 2, p.701-707, April 2019

Phytoremediation using *Salsola Baryosma* as a Halophyte Suitable for Domestic Wastewater Treatment in South-east of Algeria

KADDOUR ZINEB[1*], OUCIF KHALED MOHAMMED TAYEB[2], AND ABDERRAHMANE KHECHEKHOUCHE[3]

Phytoremediation is an ecological and environmental technique for purifying wastewater from Halloufa shott located north of El-Oued city, in Algeria. The process of using a natural plant called *Salsola Baryosma*. Two containers identical have been tested for this, the first container contains has only several layers of thick gravel, fine gravel, and soil. This container is taken as a control container (CC). The second container has the same layers of gravel but with only one modification is that the *Salsola Baryosma* plant is planted in this container (CM). The two containers are sprayed with the same amount of wastewater and the water which precipitates at the receiving bottom is analyzed. The samples were taken after 5 days and the results show that this treatment makes (CM) slightly more acidified, reduces turbidity from 98 NTU to 2.88 NTU, decreases orthophosphate concentration by 87.98%, and decreases biochemical oxygen demand, nitrate by 84%, 70% respectively. The ammonium recorded the most removal nitrogen with a percentage of 99.28%. During a five days of treatment, encouraging results were obtained with a simple method, it can therefore be said that this technique could be one of the suitable candidates for the removal of pollutants from wastewater.

Keywords : *Green Remediation, Pollutants, turbidity, halophyte species, Halloufa Shott.*

1. INTRODUCTION

The water treatment is done by several techniques and each technique has its advantages and disadvantages. For example, solar water treatment is a simple and economical method, but it suffers from the low production of pure water from used water (Khechekhouche et al. 2017, 2020a,b). Phytotechnology is another method used by plants at the interface of air, soil, and water; it can be an effective tool for removing pollutants from wastewater (Rai, 2018). To this end, The phytoremediation of pollutants with plants is an eco-sustainable, cost-effective, aesthetically pleasing, solar-driven, and passive technique for environmental management (Kumar & Deswal, 2020; Yazdani & Golestani, 2019). Thus, phytoremediation has become an increasingly recognized pathway for pollutants removal. Phytoremediation is a series of bioremediation technologies focused on plants that use different species of living plants to purify polluted soils, water and air. Using phytoremediation, organic pollutants, nutrients, heavy metals, and in the rhizosphere region, phenols can be degraded or taken up by the plant, then degraded, sequestrated or volatilized. Inorganic pollutants in harvestable vegetation cannot be degraded but can be sequestered or stabilized, particularly for the remediation of macronutrients, as shown in published manuscripts (Nouri et al. 2017; Ceschin et al. 2020). Also, around 1% of soil plant species grows and reproduces in coastal or inland saline sites. In conditions where the salt concentration is at or above 200 mM NaCl, these exceptional plants, halophytes, can live and grow and tolerate salt concentrations that kill 99% of other species. Annuals and perennials, monocotyledonous and dicotyledonous plants, shrubs, and some trees include salt-adapted halophytes (Mirza et al. 2019). It is worth mentioning that halophytes have a higher tolerance to environmental pollutants that are particularly useful for phytoremediation technology. They are capable of injecting root tissues with atmospheric oxygen and releasing it into the rhizosphere, thus regulating microbial respiration by generating redox conditions gradients (Syranidou et al. 2017). Studies were done on halophytes (*S. Baryosma*) which are plants that survive naturally, thrive, and complete their life cycle in environments contaminated by salt, they have many potential uses: phytoremediation tool, phytodesallinization tool (revegetation and sanitation of salted land), also in fodder and bioenergy, in addition to balancing the carbon cycle and reducing global warming, protecting the coasts and serving as a source of compound medicines

[1*] Laboratory Valorisation and Technology of Saharan Resources (VTRS). University of El-Oued, BP 789, El-Oued, 39000, Algeria.
[2] Process Engineering and Petrochemicals Department, University of El-Oued, Algeria.
[3] Faculty of Science and Technology, University of El Oued, PB 789, El Oued, 39000, Algeria.
[1*] The corresponding author kadzin46@gmail.com Tel: 0213 66 30 51 70
[2] mehammed-oucifkhaled@univ-eloued.dz
[3] abder03@hotmail.com

J. Environ. Science & Engg. Vol. 61, No. 2, p. 708-713, April 2019

Environmental Impacts of COVID-19 with Special Reference to Plastic Waste - A Review

P.D. CHARAN[1], GAUTAM KUMAR MEGHWANSHI[2] AND ABHISHEK VASHISHTHA[2*]

Since December 2019, SARS-CoV-2 (also known as COVID-19) has blowout over 200 countries. The WHO has already declared the COVID-19 as pandemic. Production of various goods and service sector has undergone a severe setback throughout the world. The disease has infected millions of people and still the cases are growing rapidly. The present review is focused on the overuse of plastic products to safeguard the health and medical professionals against COVID-19 and their environmental effects. Effort has also been made to cover the current researches on COVID-19. It has been noticed that lockdown laid down by different countries had positive impacts on the quality of environment. The nature is on redemption mode. But at the same time, extensive use of plastics and other non-biodegradable materials in the form of personal protective equipment's, body bags, gloves, masks, packing materials etc has increased rapidly. Food businesses including restaurants, cafeterias etc are now offering only home deliveries. This has geared-up the plastic waste buildup from its packaging. It is envisaged that the environmental concern will take over its righteous place again once the corona pandemic is overcome. But the non-biodegradable waste dumped in the nature will affect the environment for long time.

Key words: *SARS-CoV-2, COVID-19, Plastic waste, Personal protective equipment's*

Introduction:

Covid-19, a new kind of an unusual pneumonia was noticed first time in Wuhan city of China on late December, 2019 [Xu et al. 2020]. It has not only raised health issues throughout the world, but also had grown the positive as well as negative consequences on the environment. The environmental effects of COVID-19 can broadly be categorized into acute and chronic effects. One of the acute environmental effects of the pandemic is the rapid expansion in the production of surgical masks, gloves, protective equipment's, body bags etc., which are mainly comprised of plastics. Thus, these plastic products has significant role in protection of frontline workers under current situation. But the other side of coin shows that the excessive use of such non-biodegradable material severely affects different kinds of aquatic as well as terrestrial ecosystems.

It is observed that there is a prominent relationship between global lockdown and purification of the environment. As of July 2020, the Corona virus has infected over a billion individuals and has caused more than 521277 deaths [WHO, 2020]. The COVID-19 is very infectious disease but death rate is comparatively lower than SARS and MERS. A world over estimated mortality rate of 3.4% due to COVID-19 has been reported by the Time magazine. There are similarities in symptoms between influenza and COVID-19, such as fever, headache, nose and chest congestion and respiratory tract inflammation. The death toll of Severe Acute Respiratory Syndrome (SARS) has been reported about 10% for the infected people, while Middle East Respiratory Syndrome (MERS) was much severe resulting in 34% deaths of its patients [Mahase, 2020]. COVID-19 does seem to be more lethal than the seasonal flu. However, the rate of sprawl of the COVID-19 is much faster than SARS and MERS. It may be due to boom in urbanization, increased transportation facilities and travelling at global level [Peeri et al. 2020].

1.1 Current status of plastic waste in the world:

In 1950, the production of plastic was about 2 million tons per year which has increased significantly to 381 million tons per year by 2015 [Ritchie, 2018]. Due to low cost, easy to transform in any shape, hydrophobic nature, biological inert properties, stiffness and has better resistance to deformation plastic became a prime choice of material for different purposes [Lebreton and Andrady, 2019]. The trend of consumption of plastic is increasing day by day. It is estimated that by 2025, the urban population will generate more than 6 Metric tons solid wastes daily at global level [Hoornweg et al. 2013]. From 2010-2016, the share of plastic has been increased from 10-12% in the solid waste globally, which amount to 242 Metric tons in 2016 [Kaza et al. 2018]. It has been reported that the packaging and construction activities are the leading areas of the consumption of plastics [Lebreton and Andrady, 2019]. The list of world's top offenders of plastic waste generator

1 Department of Environmental Science, Maharaja Ganga Singh University, Bikaner-334004
2 Department of Microbiology, Maharaja Ganga Singh University, Bikaner-334004
* corresponding author: abhiv24@gmail.com

J. Environ. Science & Engg. Vol. 61, No. 2, p. 714-724, April 2019

Pectin-Based Composites for Energy and Environment

NAIR SREECHA CHANDRAN[1], SONIA JOHN[1], SHARREL REBELLO[2]. RESHMY R[3], RAVEENDRAN SINDHU[4], ASHOK PANDEY[5] AND PARAMESWARAN BINOD[4*]

Pectins are widely used in foods to impart a texture in high sugar systems. It is found in all plants, but the concentration in apples and citrus fruits such as lemon, grapefruit and oranges are the highest. Commercial extraction of pectin is done by treating the pectin producing feedstock with dilute mineral acids at pH in the range of 1.0 – 2.0. Pectin is an effective candidate for the formation of innovative composite material due to its physical, ionic and chemical characteristics. Currently the synthesis and applications of pectin based composites has been widely studied due to its important and valuable features. For production of novel pectin based composites, it is very important to recognize and evaluate the various interactions between mixtures of polysaccharides, which could lead to the development of novel formulations with better stability and obtain a higher cost benefit. This biopolymer based compounds are known to possess many remarkable properties that have been extensively exploited in various fields like biomedical applications, food industries, removal of heavy metals are some of the promising applications of pectin-based composites. This review gives an overview of different pectin-based composites and their application in diverse fields.

Keywords : *Pectin; Composites; Biopolymer; Polysaccharides*

1. Introduction

Pectin that are used for commercial purposes do not have a similar characterization because it shows difference in all time. But its galacturonic acid units in different plant polysaccharides has become clearer which has been studied expansively (May, 1990). Pectin mostly contains arabinose, galactose, rhamnose, xylose and glucose, which are the range of neutral sugars and they are substantially associated with other polymers and contain high content of galacturonic acid. Pectin used commercially normally contains units of galacturonic acid which are intermittent through frequent residues of sugar which are neutral. It is reported that hairy regions are formed when (Junmahasathien et al., 2018) arabinogalactans, are attached to small block of galacturonic acid residues that are attached close to each other. Galacturonic acids are highly composed in dominant regions of the chain that are esterified with methanol. Pectin therefore show an important role in different type of industries due to its relationship with polysaccharides.

An extreme difficulty occurs when the extracted pectin are obtained from different type of plant tissues which shows variations in structures of pectin. Variation in structure of pectin also arise a difference in ester group of allocation, alongside the chain backbone. Around pectins containing 78% of Citrus peels are isolated for esterification, and apple pectin of 80%. These differences are occurred because of the occurrence of esterase in the following peel. Mostly chemically esterified and hydrolysed pectin having degree of esterification is delicately different from the starting material (Chemat and Khan, 2011). These differences therefore do not lead to any functional difference with high content of galacturonic acid which states commercially produced pectin. Commercially, this pectin has a greater role in markets which are mostly used in the production of food and also pharmaceuticals. In the study of pectin production the pectin rich extract obtained from the origins of pectin production preserves manufacturers by any of the fruit trappings and ravage materials, like citrus and apple (peels), with its gelling properties.

For many years pectin have been used vastly in food. Jelling industry production of pectin used in systems with high sugar content. Pectin has been extensively studied but as a model system it is difficult to analyze because of its polymerity which is heterogeneous. In diverse areas, polymer tailoring has been found as an important need. In the cell wall of most of the plants the three pectic polysaccharides has

[1] Cashew Export Promotion Council of India (CEPCI) Laboratory and Research Institute, Kollam – 691 001, India
[2] Communicable Disease Research Laboratory, St Joseph's College, Irinjalakuda - 680121, India
[3] Post Graduate and Research Department of Chemistry, Bishop Moore College, Mavelikara -690 110, Kerala, India
[4] Microbial Processes and Technology Division, CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Trivandrum-695 019, India
[5] Center for Innovation and Translational Research, CSIR- Indian Institute of Toxicology Research (CSIR-IITR), 31 MG Marg, Lucknow-226 001, India
* Corresponding author. Tel: 91-471-2515361, Fax: 91-471-2491712 E-mail: binodkannur@niist.res.in

J. Environ. Science & Engg. Vol. 61, No. 2, p. 725-735, April 2019

Bioconversion of Low Cost Waste Material to Rhamnolipid using *Pseudomonas aeruginosa*

BHAVANA PANDEY[A], S. K. UPADHYAY[A] AND LALIT KUMAR SINGH[B]

Biosurfactants have unique properties like low toxicity, biodegradability and biocompatibility. Biosurfactants are utilized in the preparation of emulsifiers, spreading and cleaning preparations in different industries including petroleum and petrochemicals, detergents, cosmetic, pharmaceuticals and food processing industries. Biosurfactants are microbial products produced via fermentative procedure with a suitable microbial strain like *Pseudomonas aeruginosa* and utilizing a low priced by-product or waste materials as substrate. The rationale of the present investigation was to produce biosurfactant in a bioreactor using low cost substrate like crude glycerol and molasses. Glycerol is obtained in crude form from a biodiesel production facility during the transesterification reaction of waste frying oil. Rhamnolipids are an important group of surface active compounds in which rhamnose, a five carbon sugar moiety is coupled to long chain â-hydroxylated fatty acid. Mixture of di-rhamnolipid and mono-rhamnolipid was characterized by spectrophotometric method. A fast atom bombardment of mass spectrometry and FTIR spectra inveterate that the produced surface active compound was rhamnolipid and other physico-chemical methods like surface tension measured by method indicated the lowered surface tension value and critical micelle concentration (CMC) of the post fermentation liquid to 26.8mN/m and 18mg/l respectively. The emulsifying index (E-24) was found to be 75%. The maximum concentration of rhamnolipid was obtained 3.7 g/l after 72 h.

Key words : *Bioreactor, Pseudomonas sp., Crude glycerol, Rhamnolipid.*

1. INTRODUCTION

The biosurfactant is a surface active agent which reduces the surface tension. They contain hydrophobic and hydrophilic group. The array of biosurfactants in the research fields received more attention and expanded many folds in recent years. It has a wide variety of biological functions and functions in various industries e.g. in food processing, petroleum, pharma and medical industries. It also finds applications in the agricultural fields where it is used as important ingredient to prepare bio-control agents (Silva et al. 2014; Prasad et al. 2015; Rodrigues et al. 2006; Sachdev and Cameotra, 2013; Nitschke and Costa, 2007). Even our basic needs are also made up of biosurfactants such as toothpaste (Bouassida et al. 2017), health and cosmetics products etc. (Varvaresou and Lakovou, 2015). The demand for such type products are always with the increasing trends. Presently the utilization of chemically synthesized surfactants is increasing but due to their conflict to biodegradation and toxicity to ecosystem, it creates environmental problems. On the other hand biosurfactants have ecological acceptance due to several advantages like low toxicity and biodegradability. The replacement of chemically synthesized substance with the biological products (biosurfactants) is the need of the environment due to these pros of biosurfactants over chemical based surfactants.

The biosurfactants can be produced with the help of various microorganisms (Shekhar et al. 2015). In the category of bacteria *Pseudomonas species* is comprehensively researched and recognized for its competency to produce biosurfactants. These organisms showed surface activity like emulsifying activity, lowering the surface tension with low critical concentration while growing on various carbon sources (Thasavi et al. 2011). Rhamnolipids are one of the well-studied biosurfactants comes under the glycolipid category of lipids. They were described as metabolic products of *Pseudomonas aeruginosa*. Two types of glycolipids containing rhamnose (a five carbon sugar) as a carbohydrate moiety: (1) one rhamnose unit, monorhamnolipid and (2) two rhamnose units, dirhamnolipid are produced by the bacterium viz. *Pseudomonas aeruginosa* (Conceição et al. 2020). They have various industrial applications because of their solubility, foaming capacity and ability to lower the surface tension (Pociniczak et al. 2011; Kosaric, 1992). These properties are broadly utilized in the products of cosmetic industry like moisturizer, lubricant and shampoo (Varvaresou and Lakovou, 2015). Rhamnolipids are valuable to many industries due to its

[a] Department of Chemistry, Harcourt Butler Technical University Kanpur-208002 (U.P.) India
[b] Department of Biochemical Engineering, Harcourt Butler Technical University Kanpur-208002 (U.P.) India
pandey.bhavana6@gmail.com upadhyay_s_k@rediffmail.com
* corresponding author: lkumar@hbtu.ac.in