A COMPREHENSIVE REVIEW ON AN EMERGING TOOL: BIOCARRIER AND TECHNIQUES UTILIZE TO PREPARE BIOCARRIERS

A Project Report Submitted

In Partial Fulfillment of the Requirements

for the Degree of

BACHELOR OF PHARMACY

by

AJAY KUMAR
(Enrollment no. 19021020173)

Under the Supervision of

MS. JYOTI PANDEY
Assistant Professor
Galgotias University
Greater Noida

GALGOTIAS UNIVERSITY

Department of Pharmacy
GALGOTIAS UNIVERSITY
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CERTIFICATE

This is to certify that project work entitled **"A Comprehensive Review on an Emerging Tool: Biocarrier and Techniques Utilize to Prepare Biocarriers"** done by **Mr. Ajay Kumar**, is a bonafide research work under the supervision and guidance of **Ms. Jyoti Pandey,** Assistant Professor, School of Medical and Allied Sciences, Greater Noida (UP). The work is completed and ready for evaluation in partial fulfillment for the award of Bachelor of Pharmacy during the academic year 2022-2023. The project report has not formed the basis for the award of any Degree/Diploma/Fellowship or other similar title to any candidate of any University.

Date:
Place: Greater Noida (UP)

Prof. (Dr.) Pramod Kumar Sharma
Dean
School of Medical and Allied Sciences
Galgotias University
Greater Noida (U.P.)

BONAFIDE CERTIFICATE

This to certify that the project work entitled **"A Comprehensive Review on an Emerging Tool: Biocarrier and Techniques Utilize to Prepare Biocarriers"** is the bonafide research work done by **Mr. Ajay Kumar**, who carried out the research work under my supervision and guidance for the award of Bachelor of Pharmacy under Galgotias University, Greater Noida (UP) during the academic year 2022-2023. To the best of my knowledge the work reported herein is not submitted for award of any other degree or diploma of any other Institute or University.

Guide:

Ms. Jyoti Pandey
(Assistant Professor)
School of Medical and Allied Sciences
Galgotias University
Greater Noida (U.P.)

DECLARATION

I hereby declare that the work embodied in this project report entitled **"A Comprehensive Review on an Emerging Tool: Biocarrier and Techniques Utilize to Prepare Biocarriers"** in Partial fulfillment of the requirements for the award of Bachelor of Pharmacy, is a record of original and independent research work done by me during the academic year 2022-23 under the supervision and guidance of Ms. **Jyoti Pandey,** Assistant Professor, Department of Pharmacy, School of Medical and Allied Sciences, Galgotias University, Greater Noida (UP). I have not submitted this project for award of any other degree or diploma of any other Institute or University.

Date:

Place: Greater Noida (UP)

Name: Mr. Ajay Kumar

Enrollment No. 19021020173

Addmission No. 19SMAS1020112

Signature of candidate:

Acknowledgement

*Firstly, I would like to thank **'God'** and bow **'Maa Saraswati'** with those grace I'm able to complete my project work successfully with in given time frame.*

*I am acknowledging to **Prof. (Dr.) P. K. Sharma**, Dean, SMAS, Galgotias University, Greater Noida (UP), for his kind permission to carry out the present study.*

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(Ajay Kumar)

) **Enrollment No**. 19021020173

Addmission No. 19SMAS1020112

ABSTRACT

In the field of microbial treatment technology, bio-carriers are important components. Fiber-based bacterial carriers are superior to other types in many ways, including more specific surface area, improved structural designability, and improved service performance in challenging settings thanks to polypropylene (PP) fibers. Biocarriers are solids that allow the good attachment of microbes during wastewater treatment, such carrier system not having a good carrying property but also used as acid-leaching agent, effective porosity agent, good solubilizer and advance foaming agent. This carrier system provides an enclosing system for carrying a treatment material made up of different material like Polypropylene, Chitosan, Polyproline, Polypyrolidine, Cellulose derivatives etc. In this study, a modification was used to give Polypropylene fibers a positive charged film by coating chitosan, which increased the quantity of bacteria loaded. Compared to other fibers, the modified PP (MPP) fibers demonstrated improved bio-affinity. Bacteria were ten times more likely to be stuck to MPP than on PP, and alteration gave PP fibers chelating cation function. MPP might undoubtedly make a suitable candidate for a bio-carrier.

Key Word: Biocarrier, Polypropylene, MPP

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LIST OF ABBREVIATIONS

S.NO.	ABBRIVATION	MEANING
1.	PP	Poly Propylene
2.	MPP	Modified Poly Propylene
3.	LED	Light Emitting Diodes
4.	CS	Chitosan
5.	CPAM	Cationic poly acryl amide
6.	MPa	Mega Pascal
7.	%	Percentage
8.	Fig	Figure
9.	g/cm3	Gram/Centimeter^3
10.	PLA	Poly Lactic Acid
11.	PE	Poly Ethylene
12.	BDA	Binary Discriminant Analysis
13.	GAC	Granular Activated Carbon
14.	g/L	gram/liter
15.	COD/TN	Chemical Oxygen Demad/Total Nitrogen
16.	MLS	Mixed Liquor Suspended Solid
17.	L	Litre
18.	v/v	Volume/Volume
19.	cm	Centimeter
20.	DNA	Deoxyribose Nucleic Acid
21.	OTUs	Operational Taxonomic Unit
22.	SEM	Scanning Electrone Microscopy

CHAPTER: 1

INTRODUCTION

1.1 EMERGING TECHNIQUE

New technologies generate a lot of controversy in educational research and are important policy initiatives. The increase in publications and news on topics related to modern technologies shows that there is an interest in new technological issues. However, policy makers' interest in new technologies should be viewed in the context of big data, where there is no consensus on the use of the new technology. The definitions given by some of studies overlap, but they also describe unusual characteristics [1]. For example, few items highlighted the potential economic and social impacts emerging technologies can have, especially when these technologies have multiple purposes, but others place more emphasis on the uncertainty of the emerging process or new features and growth [2].

The analyst's perspective influences the understanding of the development process. Analysts may see the technology emerging because of its innovation and the need for economic society, while others may see it as an invention of technology that already exists [3-4]. In addition, new technologies are often divided into "general labels" (for example, nanotechnology and synthetic biology), but these are best dealt with independently. social characteristics and interval measures based on lack of unanimity on definition. Many types of analysis have been developed, particularly in the scientometrics community, to analyze the results of science and technology. These methods do not correlate well with the good ideas that people are trying to measure, which is the principle.

and new big data and allow more metrics and models to be used. In general, the details of the primary ideas of the innovative technologies are not given. Therefore, it is not surprising that although the methods are the same or similar, the methods of discovering and studying the phenomenon are often different. The work of Emergence is also changing. They change as new taxonomies are created in literature. Therefore, the exact nature of the phenomenon that led to this research tool has been studied in detail. These issues can limit the validity of research when trying to understand new technologies, affect the allocation of resources and the development of policies that play an important role in helping and guiding technology development.[4]

1.2 BIOCARRIER

In Simple terms, Bio-carriers are materials that provide a surface area for microbial growth, allowing for the formation of biofilms in biological wastewater treatment processes, in Fiber based microbial treatment processes LED glass treatment plan etc.

For wastewater treatment, microbial technology has been widely employed since it is more affordable, sustainable, and produces less secondary pollution [1-3]. Bacteria should be immobilized for simple control and rapid degradation of pollutants. Therefore, it's critical to create high-performance bio-carriers that are accessible, affordable, environmentally benign, and mechanically robust [2-4]. Fiber-based bacterial transporters are superior to other types in many ways, including having bigger domain-specific and multivariate variations [5]. It is currently attracting attention for its potential for self-healing, sustainable development and reducing carbon emissions [6-8]. In addition, few studies have shown that the combination of fibers and bacteria can improve the self-healing ability of cement-based materials [7] and that self-healing concrete also treated with fiber bacteria [8]. Due to surface treatment and erosion, basalt fiber has also turned into a stable bio-carrier [2-9]. Organic fiber is better than basalt fiber in acid, alkali and oxidation conditions [10] used PP and PES fibers as biofilm materials and found that the adsorptioneffect of bacteria is better when the fiber surface is rough, wettable and covered. Zhang's experiment [9], among other studies, showed that it is possible to overcome the influence of bacteria and fiber energy by replacing the fiber surface with cationic polyacrylamide (CPAM). It has also been confirmed that fiber ratio changes lead to improved bacterial adsorption [2-11]. Simple techniques are needed to provide the fibers with hydrophilic, well-loaded surfaces [11].

Example: Chitosan (CS), a natural polymer containing repeated 2-amino-2-deoxy-(1,4)-glucopyranose structural units and many positively charged amino groups, was used as a drug modifier for the formation of drug carrying system.

1.3 TYPES OF BIO-CARRIERS:

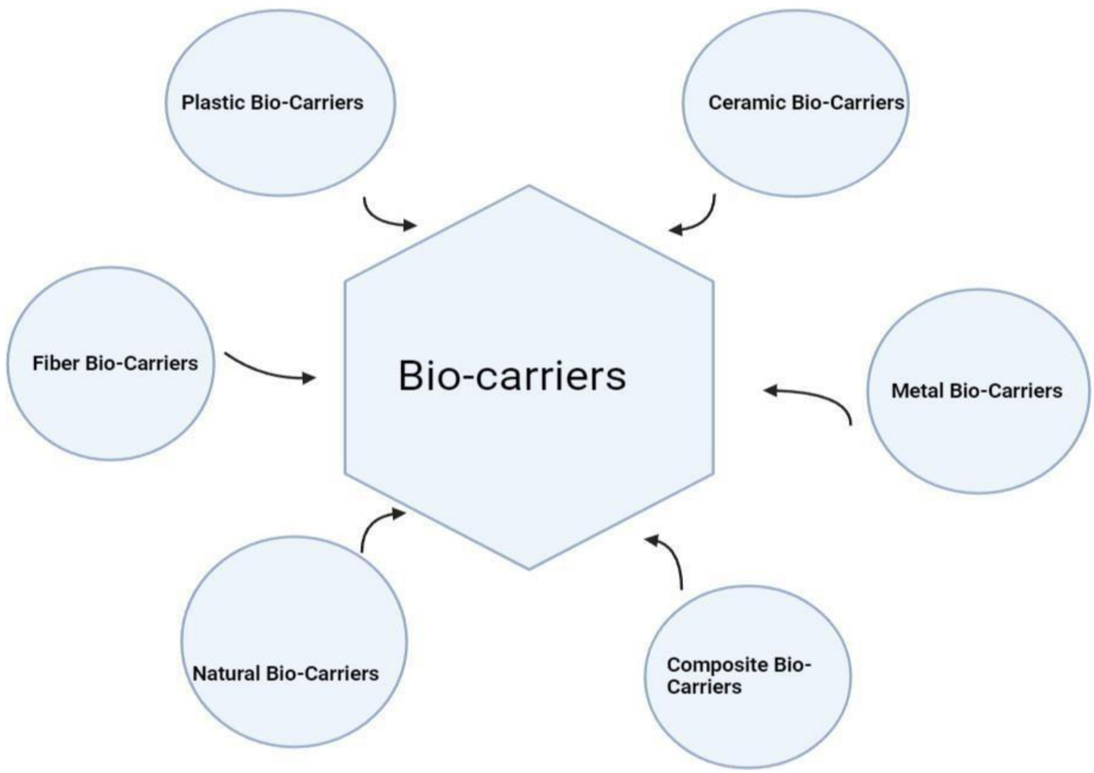

Fig 1.1: Representation of Different types of Bio-carriers

There are many types of bio-carriers available for use, including:

(i) Plastic Bio-Carriers: These are the most used bio-carriers in wastewater treatment. They are made of plastic material and are designed with a high surface area to volume ratio to maximize microbial growth.

(ii) Ceramic Bio-Carriers: Ceramic bio-carriers are made from high-quality ceramics that have a large surface area and are resistant to high temperatures and chemical degradation.

(iii) Metal Bio-Carriers: Metal bio-carriers are typically made of stainless steel, and they have high strength and durability. They are well-suited for use in harsh industrial wastewater treatment environments.

(iv) Composite Bio-Carriers: Composite bio-carriers are made by combining different materials, such as plastic and ceramics, to provide the desired surface area and mechanical strength.

(v) Natural Bio-Carriers: Natural bio-carriers include materials such as peat, coconut coir, and wood chips. They are inexpensive and environmentally friendly, but they may not provide the same level of performance as synthetic bio-carriers [12].

(vi) Fiber Bio-Carriers: Fiber bio-carriers are made from materials such as polypropylene and have a high surface area-to-volume ratio, which allows for excellent microbial growth. They are lightweight and easy to handle, making them well-suited for use in small-scale wastewater treatment systems [14].

CHAPTER: 2

REVIEW OF LITERATURE

- Ning Yu et al.[31] studies conclude, Bio-carriers with specific geographical and social characteristics are produced using special equipment. The carrier-PLA gap created by monitoringbiofilm growth at a low C/N ratio (0.83) provides a favorable environment for bacterial growth inwastewater treatment, which in turn provides some favorable conditions for biofilm growth. The growth of the biofilm over the lumen of the PLA carrier continued more rapidly compared to the bare carrier. The biomass of the biofilms grown in the carrier-PLA-space is 10 kg/m3 and the thickness is 500 m, respectively.In wastewater experiments, the biofilm biomass attached to the support PLA chamber absorbed 90% of all nitrogen via simultaneous nitrification and denitrification (SND) compared to 68% for the bare support. The COD removal efficiencies of thecarrier-PLA chamber and the bare carrier were 94% and 86%, respectively.
- Huisman et al.[32] Studies conclude, The "Western blotting" technique involves moving and immobilizing crude protein samples from the gel matrix to the appropriate phase. Since each protein has access to the corresponding antibody, it can be used to identify protein antigens in biological mixtures. Western blot is a technique that can be used to detect antibodies. Western blotis widely used in basic research. We will discuss western blot techniques and recent advances in basic techniques.
- Yilin Su et al.[33] studies about Biological products have an important place in microbial treatmenttechnology. Because of polypropylene (PP) fibers, fiber bacteria can outperform other types in many ways, including larger space, improved design, and improved performance in difficult areas.The number of bacteria loaded increased by In this study, chitosan was coated to provide a good coating to the PP fibers. Modified PP (MPP) fibers have higher biocompatibility compared to otherfibers. Bacteria are 10 times more likely to adhere to MPP than to PP, and the modifications haveobtained PP fibers with cation chelating function.MPP is undoubtedly a suitable candidate for biological products.
- Jagaba et al.[34] Reviewed biocarrier, In the last few years, many materials have grown in space as bio-carriers to immobilize microorganisms and have many advantages. The

efficiency of parallel batch biofilm reactors (SBBRs) is still poorly understood. No single product has been shown to be universally accepted for biofilm formation, as data often fall below appropriate levels.

The recent emergence of many infectious diseases has led to a problem of biocarriers. Therefore, there is an urgent need for economical and environmentally friendly biocarriers.Therefore, this

article provides a comprehensive literature review of various advances in the physical properties and performance of biocarriers between 2005 and 2021, focusing on their contribution to biofilm development, nutrient uptake, and organic matter removal. This was done to demonstrate its importance in biofilm formation. The article continues to discuss operational issues, scale-up issues, and recommendations for the use of biological materials in SBBR. Potential Future Research Directions. A sustainable and environmentally friendly solution to the problems arisingfrom wastewater treatment has also been developed, which will lead to massive commercializationof biocarriers. This article recommends future research into the efficacy of biocarriers. It is hopedthat the information in this review will expand readers' fundamental knowledge, guide future researchers, and be used in future research on biocarriers of SBBR systems.

- Wang et al.[35] studies Zinc (Zn) is an essential mineral for organisms to perform many important functions. This will have an impact onthe diversity of organisms and their participation in pollutantdegradation in biological wastewater treatment plants. To avoid wastewater (TW), a new type of Zn nanoparticles (Zn NPs) with different weights (wt.) (0, 10, 15, 20 and 30 wt%) were mixed andworked in biological products. fusion composite technology. The best performance was given by a mixed bed biofilm reactor (MBBR) with a 0.4 mg/L zinc ion release profile and a biosupport containing 20% by weight Zn NP. With more biomass (2460 mg/L) and biofilm dehydrogenase activity (approximately 350 g TPF/g), it can reduce the onset time to 11 days. Therefore, the removal efficiency of COD and NH3-N was better than reactors with other biocarriers. This suggests that biocarriers containing Zn NPs should support microbial metabolic activities and improve contaminant removal results in biofilm reactors for TW treatment.

- Puay et al.[36] Reviewed biocarrier, Engineered nanoparticles (NPs) are used at an exponential rate at the consumer, leading to an increased impact in wastewater treatment plants. In this study,the impact of zinc oxide nanoparticles (ZnO-NPs) on body activity and the wastewater treatment business community and their fate in a lab-scale sequential batch reactor process study was evaluated. ZnO-NPs have been shown to degrade activated sludge and reduce nitrogen and phosphorus removal over time. The bacterial community in the activated sludge became more diverse after exposure to ZnO-NPs, as examined by denaturing gradient gel electrophoresis.

  Extracellular polymeric substances (EPS), which form a rigid matrix to protect cells from NPs, arealso produced in large quantities. The main method of removing NPs from wastewater is adsorption to sludge.

- Maurya et al.[37], Conclude Paints are an important class of organic pollutants known to harm human and aquatic life. In this study, an attempt was made to treat wastewater containing modified biocarriers in a filled-bed bioreactor (PBBR). Contains immobilized polyurethane foam Lysinobacillus for biodegradation of Congo red dye. For use with activated charcoal and sodium alginate. The optimum processing time, sugar concentration and dye concentration were found tobe 4, respectively.Day 0, 2.0 g/L and 50 mg/L Color removal (RE) reached 92.63% under optimalconditions. At a feed load of 12 mg/L/d, continuous PBBR provided the highest RE and removal capacity of 90.73% and 10.89 mg/L/d, respectively. In addition, the Andrew-Haldane model predicted the growth kinetics of Lysinibacillus sp. The regression coefficient is 0.
- Tang et al [38]. Reviewed biocarrier, This study was designed to form a combined anaerobic-aerobic biofilm in a bioreactor and reveal its microbial community and progression. Semi-suspended biocarriers produced by 3D printing showed gradual clear DO gradients in the biofilm;this indicates that a coupled anaerobic-aerobic biofilm has been successfully formed on the surfaceof the biocarrier. The results of the metagenomic analysis showed that the structure and major types of the microbial community of the biological material were completely consistent throughout the study. These bacteria, including nitrifying and denitrifying bacteria that can be usedto removecontaminants and convert nutrients, can be

integrated into biofilms as it provides an ideal micropolyhabitat for them to stay in close proximity. As civilization progressed, the microbial community was gradually replaced by a few beneficial organisms. Collectively, these findings suggest a strategy to increase microbial diversity by creating new structures and floatingstates of biocarriers.

- Gupta et al [39]. Conclude that Due to the increase in wastewater and the presence of many resistant pollutants, the capacity of existing chemical products has been reached. Due to the necessity of biological treatment processes, moving bed biofilm reactors (MBBR) are the first choice for the treatment of organic and nutrient loads and resistant pollutants. It has a small footprint, has less competition, and improves the performance of large and mobile packages. Thisreview attempts to provide a complete overview of the use of the MBBR process and to compare its strengths and weaknesses with other bioprocesses. Operational and design factors that affect
- performance, such as aeration, biofilm thickness, fill rate of support and reactor effluent, and hydraulic retention time. MBBR has a positive effect on its performance. In addition, improving nitrification and denitrification, eliminating organic matter, saving cost during operation, etc. Various MBBR upgrades/renewals are considered for various purposes. Among these, aeration treatment, hybridization of MBBR with other biological and physicochemical processes, and modified carriers have been shown to be effective in removing organic matter and nutrients. The present review also highlights the differences in research, security considerations, and field applications of MBBR-based systems.
- Qaderi et al [40] Reviewed, Treatment of oil pollution can be done by various physical, chemical and biological methods. This contamination is biologically treated using a bed biofilm reactor. Thebed biofilm reactor was chosen in this study because of its environmental protection properties andefficiency in removing pollutants. In this study, serial moving bed biofilm reactorswere used for the first time to remove contaminants from wastewater. In this biosystem, the two- bed biofilm reactor is interconnected.For this connection, feed forward and feedback methods areused. In addition, this study used the surface response method to model the removal of oil contaminants inmoving bed biofilm reactors. Three independent parameters were examined for validity - retention time (11.23–34.77 h), strong total hydrocarbon concentration (164.78–585.22 mg/L), and media fill rate (28 .18–61.82%]—

decides on the best work. The results of this study showed that reducing the total oil hydrocarbon content of the energy and increasing the storage time and media collectioncost resulted in a lower food-to-microbe ratio, thus increasing the bacteria eradication efficiency. The test shows that the residence time is 23 hours, the total hydrocarbon concentration at the inletis 164.78 mg/L, the average fill rate is 45%, and the oil air pollution removal efficiency is 97%.Ideally, serial moving bed biofilm reactors can be used to treatwastewater due to their high efficiency.

- Saidulu et al [41] conclude Researchers are interested in developing new materials that address the shortcomings of existing materials to increase the efficiency and sustainability of wastewater treatment technologies. 3D printing has received a lot of attention for its ability to create complexgeometric patterns from a variety of composite materials. Recent advances in 3D printing in various physicochemical and biochemical wastewater treatment are up-to-date review. Significantresearch has been done on the production of feed and other materials in membranes, photocatalyticfeed separators, catalysts, scaffolds, monoliths and capsules in physicochemical processes. The mentioned 3D printing materials have many advantages, including less contamination, improved

  degradation efficiency, and the ability to recycle and reuse. Researchers are very interested in creating novel materials that can overcome the shortcomings of existing materials in order to improve the efficacy and sustainability of wastewater treatment technologies. Due of its potentialto fabricate intricate geometrical designs utilising a variety of material compositions, 3D printing has attracted a lot of attention in this regard. The recent developments in 3D printing applications for various physicochemical and biological wastewater treatment approaches are the main topic of the current review. Significant research has been conducted on the fabrication of feed spacers and other membrane components, photocatalytic feed spacers, catalysts, scaffolds, monoliths, and capsules in physicochemical treatment procedures. The aforementioned 3D printed materials have been linked to a number of benefits, including the reduction of membrane fouling, improved degrading efficiency, and possibility for recovery and reusability.
- Gong et al. [42] reviewed about ,Growth and potentiation of anammox bacteria (AnAOB) in the anmmox treatment of low ammonia-containing wastewater is difficult, especially when

sludge is used. To do this, this work presents a unique method using only sludge as inoculation and bio- carrier in a dynamic fixed bed reactor. Very good performance with 55.3 mg/L total inorganic nitrogen (TIN) and 4.1 mg/L waste TIN during 115 days of operation.An increase in anammox amount (a value traced to 1.85 mg Ng VSS 1h 1) and an increase in hzsB gene number (106 to 109 copies g dry sludge) were used using the majority of Candidatus_Brocadia. ANAOB (doubling time: 8.5 days.).

- Mazioti et al [43] conclude about, Real salty bilge water was purified using two aerobic moving bed biofilm reactors (MBBR), each containing a different type of biocarrier (K3 and Mutag BioChip). The performance of the system was evaluated by applying different pressures during operation, including brine and organic/hydraulic load shock (salinity: 40 ppt; chemical oxygen demand (COD): 9 g L-1; hydraulic retention time (HRT): 48).). - 72 hours). To identify changes in microbial communities, suspended biomass in the microbiome and biofilms were simultaneously monitored using 16S rRNA gene analysis. The two classes found in relative abundance in all MBBRs are Alphaproteobacteria (family Rhodospirillaceae and Rhodobacteraceae) and Bacteroidia (family Lentimicrobiaceae).
- Zhou et al [44]. Reviewed, Many industries, including the maritime industry, produce wastewatercontaining antibiotics. A brine MBBR-MBR (moving bed Biofilm Reactor and Membrane Bioreactor) using marine organisms has successfully treated wastewater containing synthetic NaClO. Low NaCl concentrations (below 100 mg/L) do not kill bacteria, but increase their

  biological activity and cause membrane biofouling. The half-life of membrane biofouling was found to be linear with NaClO concentration (10-100 mg/L): [half-life] = 25-0.12 [NaClO concentration].
- Martl et al.[45], conclude about, For the marine bioreactor, the greatest reduction of COD and NH3-N occurred at 30 g/L salinity. Real-time fluorescent spectroscopic measurement of normal biofouling behavior can show the extent of membrane biofouling and microbial activity in response to NaClO and NaCleffects. This article also presents a new method to monitor membraneantifoulingbased on biofouling behavior and countermeasures can be used when biofouling concentration increases.

CHAPTER: 3

AIM AND OBJECTIVE

Aim: The aim of this comprehensive review is to examine the emerging tool of biocarriers and the various techniques employed for their preparation. The review aims to provide an in-depth understanding of biocarriers, their fabrication techniques, and their potential applications in biomedical fields.

Objectives:

1. To provide an overview of biocarriers, their composition, and their significance in biomedical applications.
2. To explore the different techniques utilized for the preparation of biocarriers, including materials selection, fabrication methods, and surface modifications.

CHAPTER: 4

MATERIAL AND METHODOLOGY

4.1. Materials

Following chemicals used to prepare a biocarrier system:

- Potassium Hexacyanoferrate-III
- Polylactic acid
- Polypropylene
- Polyvidone
- Polypyrolidine
- Sodium Hydroxide
- Dichloromethane
- Granular Activated Charcoal
- Polyethylene
- Polyvinyl alcohol
- Acrylic Plastic
- Chitosan
- Zeolite
- Mineral Coal

Fig 1.2: Representation of Hexacyanoferrate-III

Fig 1.3: Representation of Poly lactic acid

Fig 1.4: Representation of Polypropylene

Fig 1.5: Representation of Polyvidone

Fig 1.6: Representation of Polypyrolidine

Fig 1.7: Representation of Sodium Hydroxide

Fig 1.8: Representation of Dichloromethane

Fig 1.9: Representation of GAC

Fig 1.10: Representation of Polyethylene alcohol

Fig 1.11: Representation of Poly vinyl

Fig 1.12: Representation of Acrylic Plastic

Fig 1.13: Representation of Zeolite

Fig 1.14: Representation of Mineral Coal

Fig 1.15: Representation of Chitosan

The Physical and Chemical Characteristics of Biocarrier materials are expressed through the table mentioned below as Table 1.1:

MATERIALS	**MP (°C)**	**BP (°C)**	**Density (g/cm3)**	**Tensile Strength (MPa)**	**Elongation (%)**	**State**
Potassium Hexacyanoferrate-III	105	-	0.96	15	90	Particle
Polylactic acid	170	-	1.25	55	5	Powder
Polypropylene	320	173	0.86	22	12	Semi Crystalline Powder
Polyvidone	180	217	1.2	1.4	163	Powder
Polypyrolidine	160	217	1.3	4.3	11.16	Powder
Sodium hydroxide	318	1388	2.13	-	-	Powder
Dichloromethane	-96.7	39	1.33	-	-	Liquid
Granular Activated Carbon	3652	4200	2.1	26.34	-	Dry Powder
Polyethylene	92	110	0.975	3.1	12.9	Liquid
Polyvinyl alcohol	200	228	1.31	48.4	220.7	Dry Powder
Acrylic Plastic	160	200	1.18	65	6.4	Solid Powder
Chitosan	215	115	0.38	26	104	Powder
Zeolite	1600	330	2.3	2	10	Powder
Mineral coal	1495	235	1.8	0.2	20.61	Solid Powder

Table 1.1 Representation of Physical and chemical properties of the materials used to prepare Biocarriers

4.2 Methods used for the formulation of Biocarriers:

(i) Two-step layer-etching process

BDP films with cavities were deposited using the two-step coating-etching technique.

Initially, PLA solution (30 g/L) was prepared by dissolving PLA. particles in CH2Cl2.

The carrier was then submerged in the PLA solution for around 60 seconds to regulate enough interaction between the carrier and coating are thoroughly wetted. The carrier also pulls at around 2 millimeters per second. Then, a thin carrier-PLA layer, namely PLA solution, is applied. Excess liquid on the loaded PLA surface was drained out. Finally, put it in carrier-PLA in NaOH solution (20 g/L) at 50 °C for 2 min. By these steps of process, the carrier-PLA-space is selected, which is a microporous space made of carrier-PLA. Wash the carrier PLA chamber with water and dry at 60°C for 15 minutes. After reaching room temperature. The number of layers is used to set the thickness of the PLA layer. Change the concentration of the NaOH solution to change the size and density of the micropore spaces on the support PLA surface. [7]

(ii) Synthetic wastewater treatment Process

Substrate, salt, insects and mineral media make up the four types of synthetic wastewater. Demand chemicals (COD), ammonium salts and nitrates were used as substrates. Tables 1.2 and 1.3 show the composition and dissolution process of the mineral medium. Table 4.1 shows the characteristics of synthetic wastewater. The COD/TN ratio of synthetic wastewater is 0.[8]

The composition of trace element and mineral components used for preparation of biocarrier based system were given below in the tables 1.2, table 1.3 and characteristics of artificial waste water shown at table 1.4:

COMPONENT	DOSAGE (g/L)
EDTA	15.000
ZnSO4.7H2O	0.430
CoCl2.6H2O	0.240
MnCl2.4H2O	0.990
CuSO4.5H2O	0.250
NaMoO4.2H2O	0.220
NiCl2.2H2O	0.190
Na2SeO4.10H2O	0.210
H3BO4	0.014
Na2WO4.2H2O	0.050

Table 1.2: Representation of the trace element and their composition

COMPONENT	DOSAGE (g/L)
NaH2PO4.2H2O	0.029
CaCl2.2H2O	0.300
MgSO4.7H2O	0.200
FeSO4.7H2O	0.00625
EDTA	0.00625

Table 1.3: Representation of the mineral components and their composition

COMPONENT	DOSAGE
COD in influent	50 mg/L
NH4 +-N in influent	50 mg/L
NO3 - -N in influent	10 mg/L
NaCl in influent	30 g/L
pH	7.0~8.2
Trace elements	1.25 mL/L
Mineral medium	As Table 2 showed

Table 1.4: Representation of the characteristics of artificial wastewater

4.3. Operation and Reactor Set-Ups

A laboratory scale batch reactor with a working volume of 22.6 L, made from commercial plexiglass boxes (size: 24 cm × 50 cm) [16]. It was divided into two sections (Figure 1). To keep the temperature at 27 C, one layer is a water bath insulation layer, one layer, was an interior reaction site zone. In the reaction zone, the carriers were suspended and lined up.

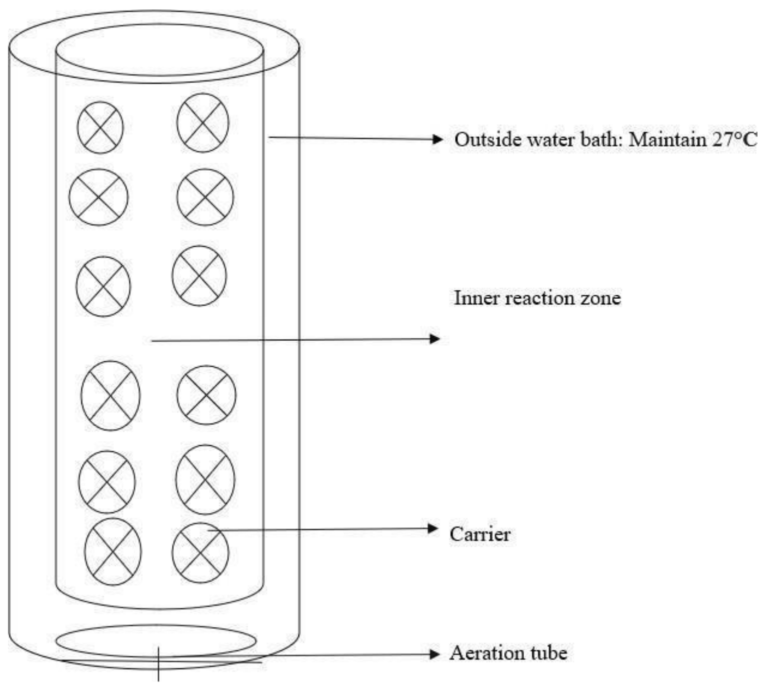

Figure 1.16. Representation of the sequencing biofilm batch reactor

The reactor is inoculated with activated sludge with a mixed liquor suspended solids (MLSS) content of 11,275 g/L and SV (speed of light) of 82. The mixed liquor from the second tank is mixed by mixing in a volume ratio of 1:3. (v/v) and the generator was run with a synthetic material aimed at stimulating biomass production on the support [16]. After 48 hours the activated sludge is removed from the reactor and then added to the waste material. Select the aerobic metabolism type to keep the stability of the experiment, with an 8-hour retention time total cycle duration that is made up of a 15-minute fill phase, 6.5-hour aerobic reaction phase, circulation, 15 minutes outside and 1 hour drain time. [16]

4.4. Properties of carriers and biofilms

(i) Preparation of Biofilm Product

LEICA-DMLP optical microscope was used to examine the carrier (carrier, carrier-PLA, and carrier-PLA cavity) at 23°C and images were taken using a CCD camera (200x magnification).

Biofilm samples adhered to the support were analyzed using an electron microscope (SEM, JSM-7800F, JEOL, Tokyo, Japan) at 5 kV acceleration. It has a 100-meter scale bar. The operating range is from 100 nm to 500 m. Take biocarrier material samples from reactors to measure the biomass they support. The difference in weight of the dry biocarrier before and after biofilm removal (105°C, 1 hour) was used to calculate the biofilm product. Components of the biofilm were removed from NaOH by grinding and sonication at 60 °C. Measure all parameters using standard methods [17].

(ii) Determination of Biofilm Thickness

Biocarriers are useful tools for the measurement of biofilm thickness, a subset of the bio-carriers was chosen. A pair of vernier calipers was used to measure the thickness of the adhering biofilm after it had been carefully sliced into numerous portions on the biocarriers. Due to the variability of biofilm thickness, ten measurements were averaged to calculate the biofilm thickness. The size and thickness of the biofilm were directly measured, the PLA layer was ignored due to insufficient thickness.

(iii) DNA extraction and analysis of the microbial community

10 g biofilm samples were taken from each reactor with similar water quality for DNA extraction and microbial community analysis. DNA was extracted from biofilms using the Power Soil DNA kit from QIAGEN, Redwood City, CA and quantified using a NanoVue plus spectrophotometer from GE, Boston, MA, USA, according to the manufacturer's instructions.

Shanghai Major BioPharma Biotechnology Co., Ltd. (Shanghai, China), Illumina PE300 sequencing was used to screen the bacterial community. Motuf was used for all data processing. Low-quality sequences were eliminated to produce high-quality sequences. These sequences included those that do not exactly match with forward primer, no gap between reverse primer, less than 200 nucleotides and an unspecified base call (Ns). Set the text to SILVER 111 compatible with the file using align sequencing tool to produce operational taxonomic units (OTUs). The probable chimaeras were then identified in the remaining sequences and eliminated. By limiting the distance between the sequences to 0.03 or 0.05 (corresponding to 97% or 95% similarity, respectively), the sequences were grouped into OTUs, and for each sample, rarefaction data as well as Shannon and Chao diversity indices were obtained.

(iv) Wastewater Analysis

Monitoring COD and total nitrogen (TN), which includes NH4-N, NO3-N, and nitrite (NO2-N), throughout the operation allowed researchers to evaluate the reactor's performance. Both of these metrics were examined using protocols that are typically used to examine wastewater [17].

Data analysis was performed using positive results after three replicates of each successful trial.

APPLICATION OF BIOCARRIER

Biocarriers are useful in the treatment of various products.

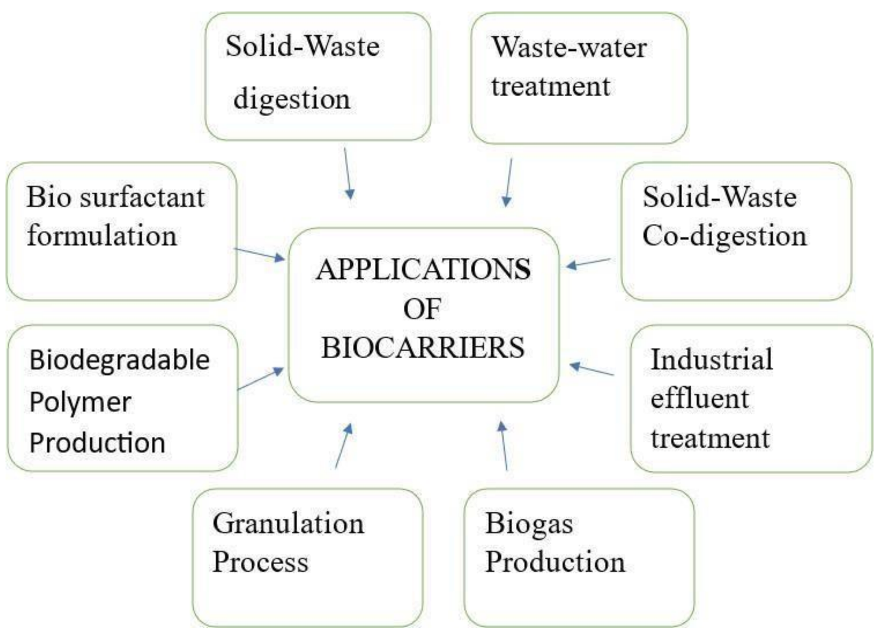

Fig 1.17: Representation of variant application of Biocarrier system

CHAPTER: 5

Evaluation of Biocarriers

There are following methods used for the evaluation of Biocarriers:

1. Optical Microscopy based on Vector-Polymer films
2. Scanning Electron Microscopy
3. Thickness determination
4. % COD removal efficiency
5. Microbial community analysis

Biocarriers are the suitable means to carry the variety of materials by which new product become more efficacious and easier to use with suitable effective measures. Some reference articles shows the following results with the use of biocarrier substances.

The adapted results are given below:

1. Optical Microscopy Structure Vector-PLA Films

In Figure 1.18, The diagram of the vector-PLA space is shown. Support, PLA film and the microporous unit of the film make it three (Adapted from 1).

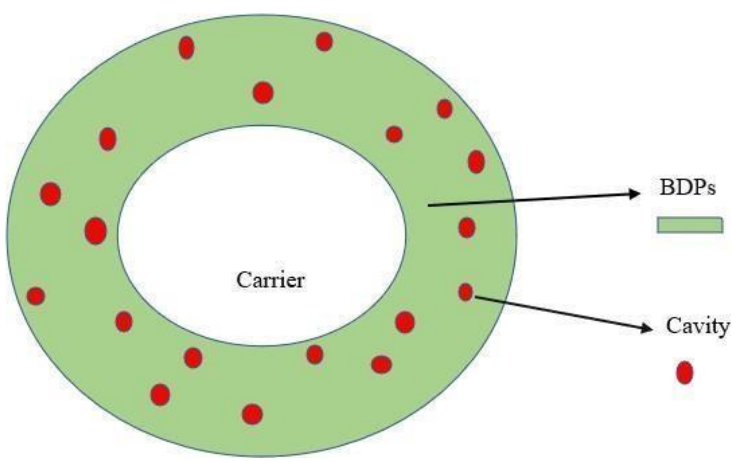

Figure 1.18 Representation of the Carrier-PLA based Cavity system.

The carrier's outside was covered with a PLA film that has a microporous chamber by using With and without the etching treatment method. Examine the structure of the PLA film under a microscope. The outside of the bare carrier is smooth (Fig. 1.19 a). A thin layer of PLA is used for the bare support after coating (Fig. 1.19 b). After the PLA film is coated, the surface of the carrier-PLA has a relatively higher amount of embossment than the carrier. After further etching, a seaisland pattern of the carrier-PLAgap was observed due to the erosion of PLA molecules by NaOH(Fig. 1.19 c) (Adapted from 1).

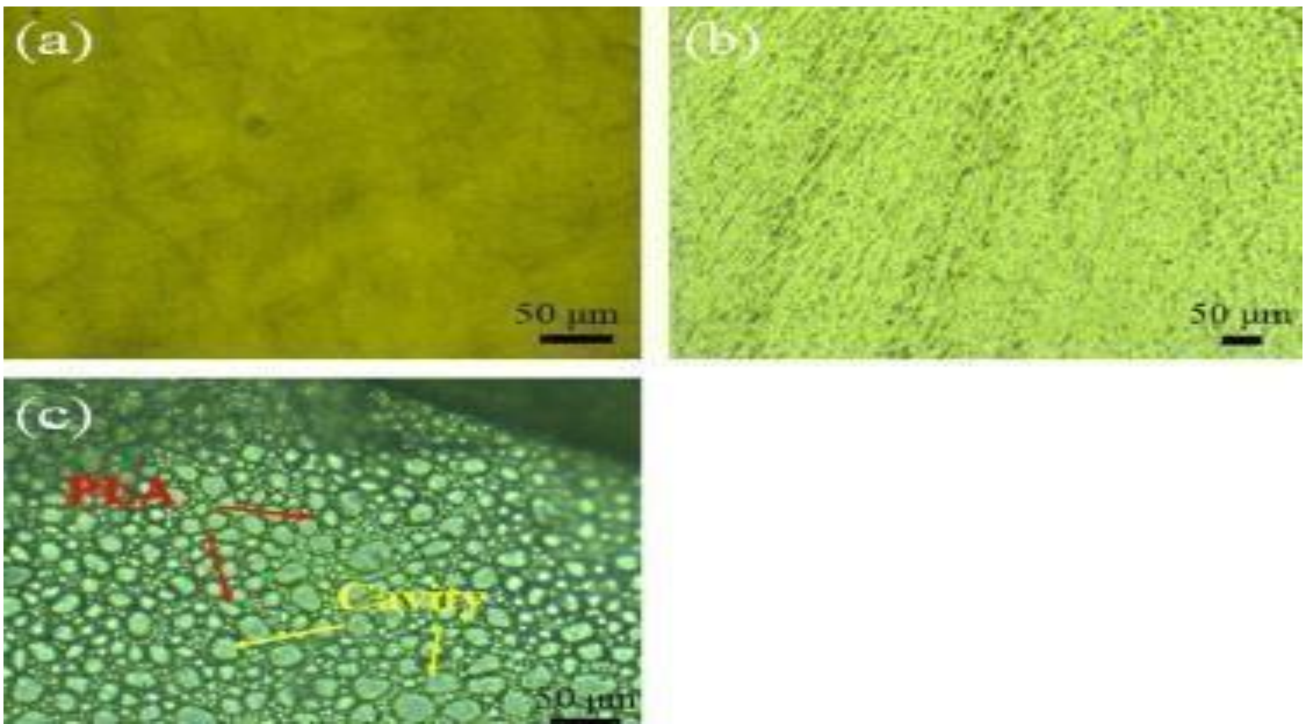

Figure 1.19: Results of microscopic structure: (a) Bare carrier system, (b) Carrier-PLA Based system and (c) Space-PLA based light system (light focus, 200 * magnification)

2. Biofilm on carrier

According to the SEM analysis, it was revealed that there was a significant difference in the structure of the carrier-PLA and the biofilm attached to the worm's cavity (Fig: 1.20).

Few studies have focused on the growth stage of biofilms on activated carbon, but doing so is important for understanding the impact of biofilms on water treatment [20,22,24,25]. Figure 1.21 shows the growth of biofilms on carriers with bare carriers and PLA voids.

Another SEM analysis shows the growth pattern of the biofilm in the colonization test was represented into four stages with certain time intervals: the incubation stage (stage I: 0-10 days), the growth stage (stage II: 10-30 days), the senescence stage (stage III: 30-45 days), and the next growth stage of the cycle (fourth stage: 45-60 days). Figure 1.21 shows that the carrier-PLAcavity has more biomass than the bare carrier because it is rougher. This continues until the third stage, where the biofilm remains stable until rain. The next cycle of biofilm growth occurs after about 40 days. [Adapted from 20,22]. Thickness and size have been used to characterize biofilm growth on supports to aid wastewater treatment.

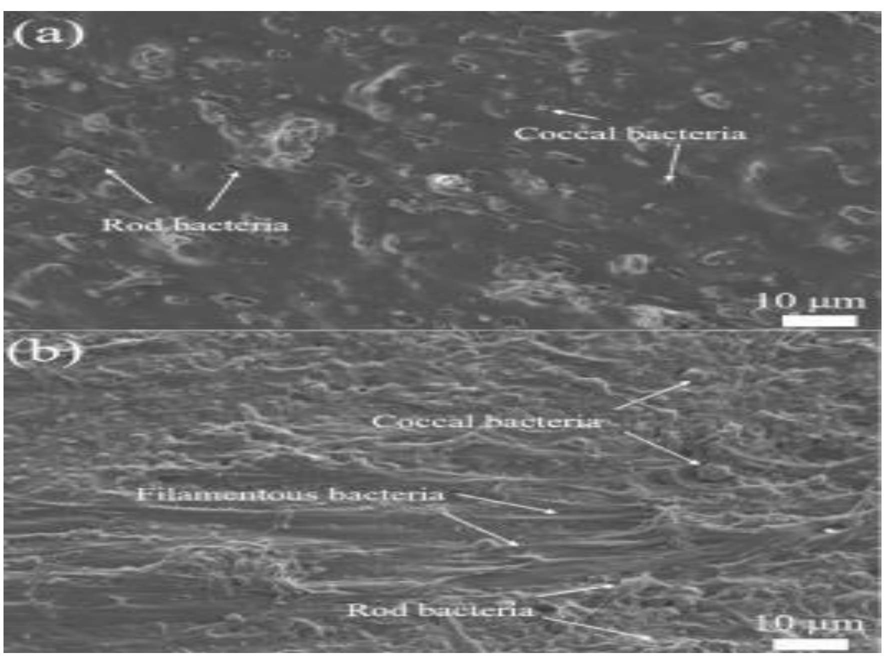

Fig 1.20: SEM of carrier-bound biofilm: (a) carrier, (b) carrier-PLA-space

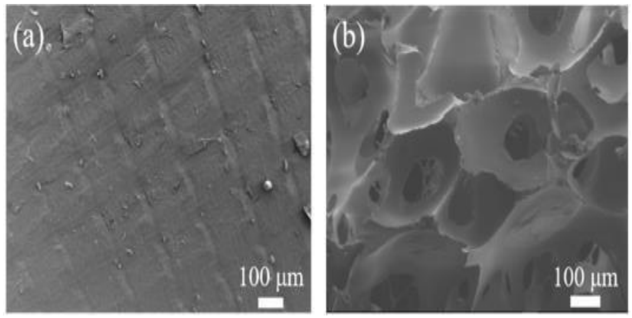

Fig 1.21: SEM of the vectors used: (a) bare vector, (b) vector-PLA-space

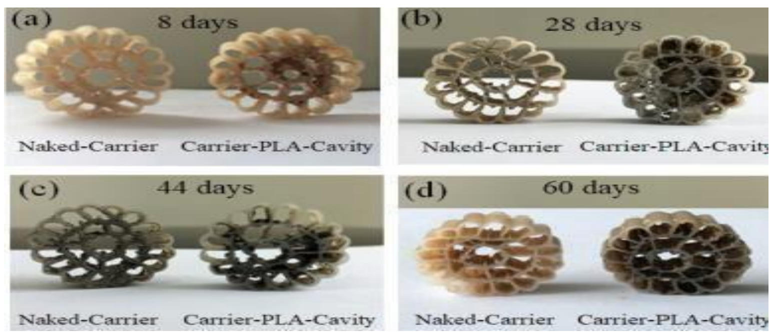

Fig 1.22. Development of bare carrier and carrier PLA cavity biofilms

3. **Thickness removal and % COD removal efficiency**: These parameters also used to determine the efficiency of Biocarriers. Thickness of biofilm prepared by using the biocarriers also used for the evaluation of biomaterials.

4. **Microbial community analysis**

Such analysis is utilized to determine the growth pattern of colonial microbial species over the biofilms. In this method Operational Taxonomic Units (OTUs), Sparseness and Species Richness bacterial population like standards were examined over the biofilms. (Adapted from 1)

CHAPTER: 6

CONCLUSION

The present study emphasizes the systematic determination of various biocarrier, their role and application which is used for the development and revival of the biofilm. Such natural films are useful support systems for the formation of drug carrier systems and certain treatment measures.

This review article also introduced the characteristics of different materials used to prepare biocarriers. Recently, PLA and PE are the first choice of polymeric agent to prepare biocarriers. Such materials have good physical property for retreatment, have longer life span than other biodegradable biocarrier agents and improved attachment site than synthetic biocarriers.

It further describes the different current techniques used for the formulation of biocarriers. Biocarriers are generally formulated by a two-step layer etching technique to create biodegradable biocarriers with an enormous surface area. By the study of different reviews, it was analyzed that layer etching methodology, which can easily and inexpensively deposit BDP thin films with microporous voids on substrates, is an effective method to produce biocarriers. It is used in the treatment of wastewater with low C/N ratio. Such natural material had an advantage to produce bioproducts, biofilms, in solid matter digestion process and treatment of wastewater at economic charges with lesser limitation. Hence, Biocarrier is more advantageous than other synthetic carrier systems.

CHAPTER: 7

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Drugs & Therapy Perspectives

A COMPREHENSIVE REVIEW ON AN EMERGING TOOL: BIOCARRIERS AND TECHNIQUES UTILIZE TO PREPARE BIOCARRIERS

--Manuscript Draft--

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Abstract:	A COMPREHENSIVE REVIEW ON AN EMERGING TOOL: BIOCARRIERS AND TECHNIQUES UTILIZE TO PREPARE BIOCARRIERS Abstract In the field of microbial treatment technology, bio-carriers are important components. Fiber-based bacterial carriers are superior to other types in many ways, including more specific surface area, improved structural designability, and improved service performance in challenging settings thanks to polypropylene (PP) fibers. Biocarriers are solids that allow the good attachment of microbes during wastewater treatment, such carrier system not having a good carrying property but also used as acid-leaching agent, effective porosity agent, good solubilizer and advance foaming agent. This carrier system provides an enclosing system for carrying a treatment material made up of different material like Polypropylene, Chitosan, Polyproline, Polypyrolidine, Cellulose derivatives etc. In this study, a modification was used to give Polypropylene fibers a positive charged film by coating chitosan, which increased the quantity of bacteria loaded. Compared to other fibers, the modified PP (MPP) fibers demonstrated improved bio-affinity. Bacteria were ten times more likely to be stuck to MPP than on PP, and alteration gave PP fibers chelating cation function. MPP might undoubtedly make a suitable candidate for a bio-carrier. Key Word: Biocarrier, Polypropylene, MPP
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