Project Completion Report

Project Type: Research Fund Grant/ R21-1877916181

Project title: Harnessing the potential of Polyhydroxyalkanoates (PHA) from *Rhodopseudomonas palustris* as sustainable resource for production of bioplastics

Introduction: Plastics are widely utilized due to their durability and low cost, however, they are mostly generated from non-renewable resources such as natural gas, petroleum, or coal and contain additives such as stabilizers and plasticizers (Filho *et al.*, 2022). These chemicals, which are commonly present in plastics like polyvinyl chloride (PVC), polypropylene (PP), and polyethylene terephthalate (PET), can be toxic, functioning as endocrine disruptors or carcinogens. They can enter the body by skin contact, ingestion, or inhalation, particularly when used in food packaging (Adeniran and Shakantu, 2022; Gaston and Tulve, 2019; Hahladakis et al., 2018; Filho *et al.*, 2021). About 76% of plastic produced globally becomes waste, with 9% recycled, 12% incinerated, and 79% landfilled or released into the environment. This improper disposal harms ecosystems and poses health risks (Geyer, Jambeck and Law, 2017; Sameh S. Ali *et al.*, 2021a; Sameh Samir Ali *et al.*, 2021b). Environmental concerns about plastic waste have driven the shift from petrochemical-based plastics to biobased, biodegradable alternatives, called bioplastics (Reddy, Reddy and Gupta, 2013). Despite their introduction in the 2000s, bioplastics still represent only about 0.5% of the over 400 million tonnes of plastic produced annually (Folino *et al.*, 2020; European Bioplastics, 2023). By 2023, production had reached 2.18 million tonnes, with biodegradable plastics making up roughly 55%. This is expected to rise to 7.43 million tonnes by 2028, driven by increasing demand and advancements in technology (European Bioplastics, 2023). Various types of biobased plastics differ in their raw materials, chemical structures, production methods, and applications, but they offer similar material properties to conventional plastics. One of the most common examples is Polyhydroxyalkanoates (PHA). PHAs are biobased polyesters that are produced as carbon/energy storage materials in microbial cells under stress. These accumulate as intracellular granules without harming the host cell. Their biodegradability and good physical and mechanical qualities make them a viable substitute for conventional petroleum-based plastics (Rajvanshi *et al.*, 2023).

PHAs are produced by various microbial species including *Rhodopseudomonas palustris* (*R. palustris*). *R. palustris* is a versatile purple non-sulfur photosynthetic bacterium popular for its ability to produce bioplastics such as PHAs from diverse carbon and nitrogen sources. It possesses the ability to switch among four metabolic modes, indicating its adaptability to various environments, such as marine sediments and waste lagoons. Along with other bacteria such as *Rhodobacter* and *Rhodospirillum*, it is capable of utilizing various carbon sources for the production of polymers. Other than this, this species possesses potential applications in biotechnology, specifically in hydrogen production, electricity generation, and bioremediation (Brown, Wilkins and Saha, 2022)**.** Despite various attempts to generate industrial PHAs utilizing microorganisms, the costs remain a significant challenge. The high cost of microbial bioplastic synthesis remains a substantial impediment to industry growth. Large-scale PHA manufacturing usually utilizes pure microbial cultures that rely on expensive sugar-based substrates, which raises overall production costs. Furthermore, the process consumes a huge amount of freshwater, reducing availability and increasing expenses (Rajvanshi *et al.*, 2023). Addressing these challenges, the present study has explored the ability of *R. palustris* to use a wide range of substrates in varied conditions for cost-effective PHA production, along with using domestic reverse osmosis (RO) reject water as the major contributor in the production process, hence reducing unsustainable freshwater use. RO reject water is rich in nutrients and free from pathogens, making it an ideal nutrient source for microbial cultivation with minimal alterations. Using this water stream can significantly reduce the costs of expensive nutrient growth media and lessen the reliance on freshwater in cultivation systems (Bhandari and Prajapati, 2022a). This approach enables more cost-effective and large-scale biomass production. This is further helping in repurposing an unmanaged waste stream of RO reject water into a useful and environmentally sustainable process of PHA production.

2. Review of literature:

Based on the literature review, Table 1 summarizes the significance of bioplastic production, highlighting the numerous industries from which waste materials can be derived as substrates. These waste substrates, including agricultural waste, food waste, and industrial byproducts, play an important role in sustainable bioplastic production by lowering dependency on fossil fuels and strengthening waste valorization.

Head Office HBC

Rajasthan State Pollution Control Board

4, Institutional Area, Jhalana Doongari, Jaipur-302 004

Phone: 0141-2716840

Registered

File No : F(HDF)/JAIPUR(Sanganer)/6935(1)/2023-2024/5986-5988

Order No : 2023-2024/HBC/2809 **Dispatch Date: Dec 14 2023 1:06PM**

Unit Id : 27890

M/s Manipal University, Jaipur

Khasra No 467,469,474,458/1,473,475, 542, 544
Village Dehmi Kalan, Tehsil Sanganer, Ajmer Road ,
Dehmi Kalan Tehsil:Sanganer
District:JAIPUR

Sub: **Consent to Establish** under Section 25/26 of the Water (Prevention & Control of Pollution) Act, 1974 and under Section 21(4) of Air (Prevention & Control of Pollution) Act, 1981**.**

Ref: Your application(s) for Consent to Establish dated 16/06/2023 and subsequent correspondence.

Sir,

Consent to Establish under the provisions of Section 25/26 of the Water (Prevention & Control of Pollution) Act, 1974 (hereinafter to be referred as the Water Act) and under Section 21 of the Air (Prevention & Control of Pollution) Act, 1981, (hereinafter to be referred as the Air Act) as amended to date and rules & the orders issued thereunder ,**is hereby granted** for your **Manipal University Jaipur plant** situated / proposed at **Khasra No 467,469,474,458/1,473,475, 542, 544 village Dehmi Dehmi Kalan Tehsil:Sanganer District:JAIPUR** , Rajasthan under the provisions of the said Act(s). This consent is granted on the basis of examination of the information furnished by you in consent application(s) and the documents submitted therewith, subject to the following conditions:-

1 That this Consent to Establish is valid for a period from **16/06/2023** to **31/05/2028 or date of commencement of production / commissioning of the project or activities whichever is earlier .**

2 That this Consent is granted for manufacturing / producing following products / by products or carrying out the following activities or operation/processes or providing following services with capacities given below:

Particular	Type	Quantity / Capacity
Gross Built up Area	Product	21,525.00 SQ. METER

3 That in case of any increase in capacity or addition / modification / alteration or change in product mix or process or raw material or fuel, the project proponent is required to obtain fresh consent to establish.

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4 That the control equipment as proposed by the applicant shall be installed before trial operation is started for which prior consent to operate under the provision of the **Water Act and Air Act** shall be obtained. This consent to establish shall not be treated as consent to operate.

5 That the quantity of effluent generation and disposal along with mode of disposal for the treated effluent shall be as under:

Type of effluent	Max. effluent generation (KLD)	Quantity of effluent to be recycled (KLD)	Quantity of treated effluent to be disposed (KLD) and mode of disposal
Domestic Sewage	24.000	16.000	5.000 Plantation and Horticulture within premises

6 That the sources of air emissions along with pollution control measures and the emission standards for the prescribed parameters shall be as under:

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Sources of Air Emissions	Pollution Control Measures	Prescribed	
		Parameter	**Standard**
Dg set(1010KVA)	ACOUSTIC ENCLOSURE , ADEQUATE AIR POLLUTION CONTROL MEASURES , ADEQUATE STACK HEIGHT , ADEQUATE STACK HEIGHT OF 30 MTR.	NOx (as NO2) (at 15% O2) day basis in ppmv	710 mg/Nm3
		NMHC (as C) (at 15% O2)	100 mg/Nm3
		PM (at 15% O2)	75 mg/Nm3
		CO (at 15% O2)	150 mg/Nm3

7 That the Domestic Sewage shall be treated before disposal so as to conform to the standards prescribed by the Board as notified under the Environment (Protection) Act-1986 for disposal **Into Inland Surface Water**. The main parameters for regular monitoring shall be as under:

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Parameters	Standards
Oil and Grease	Not to exceed 10 mg/l
pH Value	Between 6.5 to 9.0
Biochemical Oxygen Demand (3 days at 27C)	Not to exceed 10 mg/l
Chemical Oxygen Demand	Not to exceed 50 mg/l
NH4 (N)	5 mg/l
N total	10 mg/l
Total Suspended Solids	Not to exceed 20 mg/l
Fecal Coliform (MPN per 100 ml)	Not to exceed 100

8 That the unit shall obtain all necessary permission from District Administration, Jaipur and Government of Rajasthan related to establishment of new academic block "Block-3" in "Manipal University", Khasra No 467, 469, 474, 458/1, 473, 475, 542, 544 Village Dehmi Kalan, Tehsil Sanganer, Ajmer Road, Tehsil: Sanganer District: JAIPUR, Rajasthan.

9 That this consent to establish is being issued for Academic Block-3 for Gross Built Up area: 21,525 Sq.m. For any change in area, the unit has to seek fresh consent to establish.

10 That if the project cost exceeds Rs. 104 Crore, the unit shall take/obtain modification in consent after paying fee as applicable.

11 That the unit shall provide adequate & safe infrastructure facility (step ladder) for monitoring at stack of D.G. set.

12 That the unit shall apply for CTO for Built up area @ 21,525 sq.m. within 15 days time period.

13 That the unit shall get amendment in all the previous CTOs for correct Built up area, where the same have been obtained for increased Built up area as compared to approved map.

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14 That unit shall comply standards as specified in Environment (Protection) Act,1986, (Limiting concentration in mg/l, except for pH):
i. pH: 6.5-9.0
ii. BOD 3days, 27 degree Celsius: 10
iii. COD: 50
iv. Oil & Grease : 10
v. TSS: 20
vi. N-total : 10
vii. Fecal Coliform : 100 MPN/100 ml
viii. NH4-N : 5

15 That the unit shall comply with the standards as prescribed vide MOEF notification no. GSR 826(E) dated 16th November, 2009 with respect to National Ambient Air Quality.

16 That the unit shall ensure compliance of ambient air quality standard in respect of noise as prescribed under Environment (Protection) Act & Rules made therein.

17 That unit shall provide adequate stack height along with acoustic enclosures on one D.G. set of 1010 KVA. Further unit shall not allow installing any air pollution source i.e. Boiler/Hot water generation etc. without prior consent to establish from the Board under the Air Act 1981.

18 That the total water consumption shall not exceed 30 KLD. The ground water shall not be abstracted without prior NOC from Central Ground Water Authority.

19 That the water flow meters shall be provided at all suitable points to measure quantity of daily water consumption, waste water generation, waste water treated and treated waste water recycled and utilized for plantation/gardening purposes. Daily record of the same shall be maintained and to be submitted to the Board.

20 That the unit shall ensure proper recycling and reuse of domestic waste water after adequate treatment.

21 That the entire domestic waste water generated in tune of 24 KLD shall be treated through existing sewage treatment plant having capacity of 500 KLD (150 KLD +350 KLD).

22 That the unit shall maintain condition of STP of capacity 500 KLD (150 KLD +350 KLD) to achieve the standards prescribed under EP Act 1986 and the unit shall dispose the sludge of STP in scientific manner.

23 That the unit shall provide disinfection system for STP treated water before its utilization in plantation/horticulture purpose.

24 That the unit shall dispose the sludge of STP in scientific manner.

25 That the unit shall not allow making any obstacles to any natural water flow i.e. natural nallah/stream carrying rain water to any water body.

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26 That the unit shall install adequately designed rain water harvesting structure for prevention and recharge of ground water in and around the area.

27 That energy conservation measures like installation of CFLs/FLs for lighting the areas outside the building should be integral part of the project design and should be in place before project commissioning.

28 That used CFL/FLs/LEDs should be properly collected and disposed off/sent for re-cycling as per prevailing rules/guidelines issued by regulatory authority. Use of solar panels also be done to the extent possible.

29 That the solid waste generated should be properly collected & segregated. Wet garbage should be composted and dry/inert solid waste should be disposed off at approved sites for land filling after recovering recyclable materials.

30 That the unit shall comply with the provisions of Hazardous and Other Wastes(Management and Transboundary Movement) Rules, 2016; Solid Waste Management Rules, 2016; Plastic Waste Management Rules 2016; Construction And Demolition Waste Management Rules 2016; Bio-Medical Waste Management Rules, 2016 and E- Waste Management Rules, 2016.

31 That the unit shall ensure proper recycling and reuse of domestic waste water after adequate treatment.

32 That waste water shall always be conveyed/ carried through closed conduit pipe line and no other measure of carrying waste water such as tankers, flexible or temporary pipe line shall be used/practiced.

33 That water meters shall be installed at suitable locations at closed conduit pipe line to measure the quantity of effluent reaching to 500 KLD (150 KLD +350 KLD) STP for treatment.

34 That the surplus/excess/unutilized treated water shall be used for agriculture/plantation.

35 That unit shall utilize entire treated waste water for flushing/process/gardening/non-potable uses and other gainful purpose and zero discharge status shall be maintained outside the premises. No waste water shall be discharged on land/ into sewer line/into natural nala/water body/drain

36 That the unit shall not allow making any obstacles to any natural water flow i.e. natural nallah/stream carrying rain water to any water body.

37 That this consent is being issued on the basis of information /documents submitted by the industry. In case, it is found during post inspection that, the unit has flouted the conditions of consent or provided inadequate control measures & wrong information, the consent may be revoked and action may be initiated under the Provisions of Water Act & Air Act without any further notice.

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38 **That the industry shall comply provisions 9(4) & 13(2) of Plastic Waste Management (PWM) Rules -2016 and as amended & shall submit application for registration in form-I to State Board.**

39 **That no Single use Plastic (SUP) items, which are banned vide Ministry of Environment, Forest and Climate Change (MoEF& CC), Government of India notification dated 12/08/2021 shall be used in the unit premises.**

40 **That this consent to establish shall be subject to compliance of any direction or order passed by Court of Law/NGT/CAQM in the matter.**

41 **That the unit shall obtain necessary permission from National Board for Wildlife Clearance (NBWL), if the project falls in ESZ of Notified protected Area and the activity is not covered under permitted activity. The consent is granted under the provisions of Water Act, 1974 and Air Act, 1981 and any other permission/consent w.r.t. Environment Protection Act, 1986 and Forest Conservation Act, 1980, if required, shall have to be obtained before implementation of the project.**

42 **That all the green building concepts/ norms shall be adopted in all possible ways which includes Green walls, solar energy etc., and compliance of this condition shall be submitted along with photograph during the time of CTO application.**

43 **That proper C&D mechanism shall be adopted, and compliance of this condition shall be submitted along with photograph during the time of CTO application.**

44 **That proper wash disposal system shall be developed, and compliance of this condition shall be submitted along with photograph during the time of CTO application.**

45 **That water harvesting system shall be developed for maximum storage and moisture improvement, and compliance of this condition shall be submitted along with photograph during the time of CTO application.**

46 **That proper ventilation measures for energy saving, less toxic materials for reducing indoor pollution and usage of certified wood shall be considered, and compliance of this condition shall be submitted along with photograph during the time of CTO application.**

47 **That proper waste segregation system to be developed.**

48 **That the unit shall take steps to enhance landscaping and green cover in all possible spaces and develop green belt in at least 33% of the total project area.**

49 That, notwithstanding anything provided hereinabove, the State Board shall have the power and reserves its right, as contained **under Section 27(2) of the Water Act and under Section 21(6) of the Air Act** to review anyone or all of the conditions imposed here in above and to make such variation as it deems fit for the purpose of compliance of the **Water Act and Air Act**.

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50 That the grant of this **Consent to Establish** is issued from the environmental angle only, and does not absolve the project proponent from the other statutory obligations prescribed under any other law or any other instrument in force. The sole and complete responsibility, to comply with the conditions laid down in all other laws for the time-being in force, rests with the industry/ unit/ project proponent.

51 That the grant of this **Consent to Establish** shall not, in any way, adversely affect or jeopardize the legal proceedings, if any, instituted in the past or that could be instituted against you by the State Board for violation of the provisions of the Act or the Rules made thereunder.

This **Consent to Establish** shall also be subject, besides the aforesaid specific conditions, to the general conditions given in the enclosed Annexure. The project proponent will comply with the provisions of the **Water Act and Air Act** and to such other conditions as may, from time to time, be specified by the State Board under the provisions of the aforesaid Act(s). Please note that, non compliance of any of the above stated conditions would tantamount to revocation of **Consent to Establish** and project proponent / occupier shall be liable for legal action under the relevant provisions of the said Act(s).

This bears approval of the competent authority.

Yours sincerely,

Group Incharge[HBC]

(A): **Copy to:-**

1 Regional Officer, Regional Office, Rajasthan State Pollution Control Board, Jaipur (south) with request to ensure compliance of consent conditions.

2 Master File.

Group Incharge[HBC]

EC for Academic Block — Copy

State Level Environment Impact Assessment Authority. Rajasthan

4, Institutional Area, Jhalana Doongri, Jaipur-302004
Phone: 0141-2705633, 2711329 Ext. 361

No: F1(4)/SEIAA/SEAC-Raj/Secty/Project/Cat 8(a)B1 (194) /08-09 Jaipur, Dated: 29-12-09

To,

M/s Manipal Universal Learning P. Ltd.,
Manipal Towers,
14-HAL Airport Road,
Bangalore

Sub: EC for proposed Manipal Education Project village Dehmi Kalan, Teh. Sanganer, Jaipur by Mr. R.Shankar, V.P. (Project), Manipal Universal Learning P. Ltd., Manipal Towers, 14-HAL Airport Road, Bangalore.

Sir,

This has reference to your application No Nil dated 12-06-09 seeking environmental clearances for the above project under EIA Notification 2006. The proposal has been appraised as per prescribed procedure in the light of provisions under the EIA Notification 2006 on the basis of the mandatory documents enclosed with the application viz. the questionnaire, EIA EMP and additional clarifications furnished in response to the observation of the State Level Expert Committee Rajasthan, in its meetings held on 18/19.11.09.

2. **Brief details of the Project:**

1.	Category: -	"B"
2.	Item No (in the Schedule):	8(a)
3.	Purpose	Educational Project
4.	Location	Village-Dehmi Kalan, Tehsil-Sanganer, Distt.-Jaipur.
5.	Total Plot area	2, 69,801.80 M^2. (66.67 Acres / 26.98Ha)
6.	Built Up Area	2, 31,242.75 M^2.
7.	Utilized ground coverage:	14.48 %.
8.	FAR	Achieved FAR 68%
9.	Maximum Building Height	Not Provided
10.	No. of Floors	Not Provided.
11.	Total Parking Area	40,000 M^2 under surface parking. Parking provided for 670 Cars, 536 Two Wheelers, 135 Cycles.
12.	Expected Cost: -	Rs. 583 Crores - Development Cost; Rs. 36.1944 Crores - Land Cost
13.	Power Requirement	8 MVA during I-Phase through RSEB. Installation of 4 DG Sets proposed (2x2000 KVA, 2x1000 KVA; Diesel Consumption @ 5.4 ltr/hour).
14.	Water Requirement & Source	923 KLD. Source: Tube Wells. A letter dt. 08.10.2009 has been sent by the P.P. to the Central Ground Water Authority for permission to install the required 6 nos. of tube wells.
15.	Environmental Management Plan	1) 62018.50 M^2 (approx. 23 %) is available under parks and green belt. 2) 40,000 Sq. M. is available for surface parking. 3) Rain Water Harvesting 4) A STP of 1075 KLD capacity.

3. The SEAC Rajasthan after due considerations of the relevant documents submitted by the project proponent and additional clarifications/documents furnished to it have recommended for Environmental Clearance with certain stipulations. The SEIAA Rajasthan after considering the proposal and recommendations of the SEAC Rajasthan hereby accord Environmental Clearance to the project as per the provisions of Environmental Impact Assessment Notification 2006 and its subsequent amendments, subject to strict compliance of the terms and conditions as follows:

M.S. Pollution Control Board

A

PART A: SPECIFIC CONDITIONS

I. CONSTRUCTION PHASE

i. "Consent to Establish" shall be obtained from Rajasthan State Pollution Control Board and a copy shall be submitted to the SEIAA, Rajasthan before start of any construction work at the site and submit the following documents to RPCB at the time of applying for CTE:
   - ✓ Identification of re-cycling plant with its process.

ii. For conservation of electricity and to reduce energy losses the management should ensure that the electrical voltage is stepped down from 33 KV to 11 KV and distributed at this level and finally brought to 440 volts.

iii. Provision shall be made for the housing of construction labor within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structures to be removed after the completion of the project.

iv. All required sanitary and hygienic measures shall be in place before starting construction activities. The safe disposal of waste water and solid waste generated during the contraction phase should be ensured.

v. Adequate drinking water facilities shall be provided for construction workers at the site.

vi. Provisions should be made for the supply of fuel (kerosene or cooking gas); utensils such as pressure cookers etc. to the labourers.

vii. All the labourers engaged for construction should be screened for health and adequately treated before engaging them to work at the site.

viii. For disinfection of waste water, appropriate tertiary treatment may be given.

ix. All the topsoil excavated during the construction should be stored for use in horticulture/landscape development within the project site.

x. Disposal of muck during construction phase should not create any adverse effect on the neighboring communities and be disposed taking the necessary precautions for general safety and health aspects of the people, only in approved sites with the approval of competent authority

xi. Soil and ground water samples will be tested to ascertain that there is no threat to the ground water quality by leaching of heavy metals and other toxic contaminants.

xii. Construction spoils, including bituminous material and other hazardous materials must not be allowed to contaminate water courses and the dump sites for such material must be secured so that they do not leach into the ground water.

xiii. The diesel generator sets to be used during the construction phase should be low- sulphur-diesel type and should conform to Environment (Protection) Rules for air and noise emission standards.

xiv. Vehicles hired for bringing construction material and labourers to the site should be in good conditions and should conform to applicable air and noise emission standards and should be operated during non-peak/approved hours.

xv. Ambient noise levels should conform to residential standards both during day and night. Incremental pollution loads on the ambient air and noise quality should be closely monitored during construction phase.

xvi. Fly ash should be used as building material in the construction as per the provisions of Fly Ash notification of September,1999 and amended as on August, 2003 (The above condition is applicable only if the project is within 100 km of Thermal Power Station).

xvii. Ready mixed concrete must be used in building construction.

xviii. Storm water control and its re-use as per CGWA and BIS standards for various applications.

xix. Water demand during construction should be reduced by the use of pre-mixed concrete, curing agents and other best practices.

xx. Permission to draw ground water shall be obtained from the CGWA/CGWB prior to construction/operation of the project.

xxi. Separation of grey and black water should be done by the use of dual plumping line for separation of grey and black water.

xxii. Treatment of 100% grey water by decentralized treatment should be done.

xxiii. Fixtures for showers, toilet flushing and drinking should be of low flow either by use of aerators of pressure reducing devices or sensor based control.

xxiv. Use of glass may be reduced by up to 40% to reduce the electricity consumption and load in air-conditioning. If necessary, use high quality double glass with special reflective coating windows.

xxv. Roof should meet prescriptive requirement as per Energy Conservation Building Code by using appropriate thermal insulation material to fulfill requirement.

(18) (28)

xxv. Adequate measures shall be taken to reduce air and noise pollution during construction keeping in mind CPCB norms on noise limits.

xxvi. Opaque walls should meet prescriptive requirement as per Energy Conservation Building Code for all air-conditioned spaces, whereas, for non- air-conditioned spaces, by use of appropriate thermal insulation material to fulfill the requirement.

xxvii. A First Aid Room will be provided in the project both during construction and operation of the project.

xxix. Any hazardous waste generated during construction phase should be disposed off as per applicable rules and norms with necessary authorization of the Rajasthan Pollution Control Board.

xxx. The approval of the competent authority shall be obtained for structural safety of the building due to earthquake, adequacy of fire fighting equipments, etc as per National Building Code 2005 including protection measures from lightening etc.

xxxi. Regular supervision of the above and other measures for monitoring should be in place throughout the construction phase, so as to avoid nuisance to the surroundings.

xxxii. Approved plan from competent Authority and position with reference to Master Plan.

xxxiii. Copy of guidelines issued by concerned ministry for water scarce area is provided.

xxxiv. Ground water table to be shown along with source. Besides, permission of competent authority is obtained for withdrawal of ground water.

xxxv. Recalculate MSW quantity and revise disposal proposal.

xxxvi. Composting of biodegradable waste shall be carried out with in the campus.

xxxvii. Provision of solar water heating /chilling etc shall be explored.

xxxviii. Review and revise the requirement of DG set capacities for 100% power back up through to optimization of power back up in case of power failure and emergency.

(B)

II OPERATION PHASE

i. An independent expert shall certify the installation of the Sewage Treatment Plant (STP) and a report in this regard shall be submitted to the RPCB, before the project is commissioned for operation. Discharge of treated sewage shall conform to the norms & standards of the Rajasthan State Pollution Control Board.

ii. For conservation of electricity and to reduce energy losses the management should ensure that the electrical voltage is stepped down from 33 KV to 11 KV and distributed at this level and finally brought to 440 volts.

iii. Rain Water harvesting (RWH) for roof run-off and surface run-off, as plan submitted shall be implemented. Before recharging the surface run off, pre-treatment must be done to remove suspended matter, oil and grease. The RWH plan should as per GOI manual

iv. The solid waste generated should be properly collected & segregated before disposal to the City Municipal Facility. The in-vessel bio-conversion technique may be used for composting the organic waste.

v. Any hazardous waste including biomedical waste should be disposed of as per applicable Rules & norms with necessary approvals of the Rajasthan State Pollution Control Board.

vi. The green belt design along the periphery of the plot shall achieve attenuation factor conforming to the day and night noise standards prescribed for residential land use. The open space inside the plot should be suitably landscaped and covered with vegetation of indigenous variety.

vii. The D. G. sets to be operated with stack height as per RPCB norms.

viii. Incremental pollution loads on the ambient air quality noise and water quality shall be periodically monitored after commissioning of the project.

ix. Application of solar energy should be incorporated to illumination of common areas, lighting for gardens and street lighting in addition to provision for solar water heating. A hybrid system or fully solar system for a portion of the apartments should be provided.

x. Traffic congestion near the entry and exit points from the roads adjoining the proposed project site must be avoided. Parking should be fully internalized and no public space should be utilized.

xi. A Report on the energy conservation measures confirming to energy conservation norms finalize by Bureau of Energy Efficiency should be prepared incorporating details about building materials & technology, R & U Factors etc. Quantify energy saving measures.

xii. Proper system of channelizing excess storm water shall be provided.

xiii. The power factor should be maintained near unity.

xiv. Trees and shrubs of local species should be planted to allow habitat for birds with appropriate distance from the boundary.

xv. No puzzle parking shall be allowed.

xvi. Re-cycled water to match standards for cooling water system.

xvii. Adequate measures should be taken to prevent odor from solid waste processing and STP.

PART – B. GENERAL CONDITIONS:

1. The environmental safeguards contained in Form 1-A should be implemented in letter and spirit.
2. Six monthly monitoring reports should be submitted to Rajasthan and Rajasthan State Pollution Control Board.
3. Officials of the RPCB, who would be monitoring the implementation of environmental safeguards, should be given full cooperation facilities and documents/data by the PP during their inspection. A complete set of all the documents submitted to SEIAA, Rajasthan should be forwarded to the DoE, Rajasthan and Rajasthan State Pollution Control Board.
4. In case of any change(s) in the scope of the project, the PP requires a fresh appraisal by SEIAA/SEAC, Rajasthan.
5. The SEIAA/SEAC, Rajasthan reserves the right to add additional safeguard measures subsequently, if found necessary, and to take action including revoking of the environmental clearance under the provisions of the Environment (Protection) Act-1986, to ensure effective implementation of the suggested safeguard measures in a time bound and satisfactory manner.
6. All the other statutory clearances such as the approvals for storage of diesel from the Chief Controller of Explosives, Fire department, Civil Aviation Department, Forest Conservation Act, 1980 and Wildlife (protection) Act,1972 etc. shall be obtained, as may be applicable, by PP from the competent authority.
7. The PP should ensure advertising in at least two local news papers widely circulated in the region, one of which shall be in vernacular language that, the project has been accorded environmental clearance and copies of the clearance letters are available with SEIAA, Rajasthan and the Rajasthan State Pollution Control Board and may also be seen on the website of the Board at www.rpcb.nic.in. The advertisement should be made within 7(seven) days from the date of issue of the environmental clearance and a copy should also be forwarded to the SEIAA, Rajasthan and Regional Office, Jaipur(5) of the Board.
8. These stipulations would also be enforced amongst the others under the provisions of Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, the Public Liability (Insurance) Act, 1991 and EIA Notification, 2006.
9. Environment clearance is subject to final order of the Hon'ble Supreme Court of India in the matter of Goa Foundation Vs. Union of India in Writ Petition(Civil) No. 460 of the year 2004 as may be applicable to this project.

Yours faithfully,

Sd/-
(Sankatha Prasad)
Member Secretary
SEIAA Rajasthan

Copy to following for information and necessary action:

1. Secretary, Ministry of Environment and Forest, Govt. of India, Paryavaran Bhavan, CGO Complex, Lodhi Road, New Delhi.
2. Principal Secretary, Environment Department, Rajasthan, Jaipur.
3. Shri S.C. Derashri, Chairman, SEIAA Rajasthan, 90, Geejgarh Vihar, Hawa Sarak, Jaipur.
4. Shri R.S. Bhandari, Member, SEIAA Rajasthan, 2- Museum Road, Ram Niwas Bagh, Jaipur.
5. Member Secretary, Rajasthan State Pollution Control Board, Jaipur.
6. Member Secretary, SEAC Rajasthan.
7. The CCF, Regional Office, Ministry of Environment & Forests, RO(CZ), Kendriya Bhawan, 5th Floor, Sector 'H', Aliganj, Lucknow-226 020.
8. IA- Division, Monitoring Cell, MoEF, Paryavaran Bhavan, CGO Complex, Lodhi Road, New Delhi-110003.

M.S. SEIAA (Rajasthan)

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List of Local Bodies involved with Manipal University Jaipur in projects which Impacts SDG policies and work:

Sr. No	Activity	Body	SDG
1	Legal Aid Clinic On Law Summit 2nd Edition In Collaboration	District Legal Services Authorities (DLSA), Jaipur	16
2	Nyaya Bandhu	Pro Bono In Collaboration With District Legal Services Authority	16
3	Alternative Dispute Resolution Method- Mediation At Village Panchayat	District Legal Services Authorities, Jaipur	16
4	SPARK CELEBRATION: Spark In Every Child Towards A Healthy And Drug Free Society	NMP MEDICAL RESEARCH INSTITUTE And DEPARTMENT OF SOCIAL JUSTICE AND EMPOWERMENT, GOVT. Of Rajasthan	3
5	Serv Skisha Abhyan	Department Of Education, Government Of Rajasthan	4
6	Swach Bharat_ocotber 25 2023	Rotary Club Bapu Nagar	15
7	Kona Kona Shiksha	National Institute Of Securities Market	
8	Law Of Taxation	Rajasthan High Court	16
9	Navigating Complex Legal Waters: Crossborder Insolvency And Global Business Resilience	Karnataka High Court	16
10	9th Manipal Ranka International Moot Court Competition-2023	Ranka Foundation	5,16
11	Semiconductor Industry In India- Future Trends In VLSI Technology	Truechip Solutions	9

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2	Providing Low Cost Solution And Appropriate Management Framework For The Reject Disposal Of Community-based Ro Plants In Many Areas Of Rajasthan	Department Of Science & Technology (DST), Government Of India	Dr Monika Sogani	SDG-6&13
3	Cinema Main Bhartiyata	Indian Council Of Social Science Research (ICSSR)	Dr Amit Sharma	SDG-11
4	Development And Utilization Of High Value Products From Waste Resources: Circular	Department Of Science & Technology (DST), Government Of India	Dr Rohit Jain	SDG-12
5	Sequential Adsorption Of Mixture Of Dyes In A Multibed Adsorption System Using A Low-cost Adsorbent	SERB Power Grant		SDG13
6	Computational Study Of Nanoalloy Clusters For Potential Applications In Energy Sector	Science And Engineering Research Board (SERB)	Dr Prabhat Ranjan	SDG-7

7	Hybrid Irrigation System For Smart Agriculture Using Iot	Unnat Bharat Abhiyan Centre For Rural Development And Technology IIT Delhi	Dr Devershi Pallavi Bhatt	SDG-9
8	In Silico Identification, Design And Evaluation Of Small Molecule Inhibitors Against Nicotinamidase (Pnca) And Nicotinate Phosphoribosyltransferase (Pncb) From Methicillin Resistant Staphylococcus Aur	Indian Council Of Medical Research ,New Delhi	Dr Sandeep Kumar Srivastava	SDG-12, SDG 9 & SDG 13

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2	New Products From Pomegranate	Rham Food And Processors (Opc) Private Limited	Dr Mousumi Debnath	
3	Harnessing The Potential Of Polyhydroxyalkanoates (Pha) From Rhodopseudomonas Palustris As Sustainable Resource For Production Of Bioplastics	Royal Institution Mcgill University	Dr Monika Sogani	Sdg-7 & Sdg 13

4	Development Of Flexible Sensors	Chipsor Labs Private Limited	Dr Sanchita B Ghosh	Sdg-7 & Sdg 12

List of NGOs participate in cross-sectoral dialogue about the SDGs:

Astha Foundation	SDG-2
Every Person's Hope Foundation	SDG-1 & SDG-2
Naya Savera NGO, Nirman Nagar	SDG-2 & SDG-3
Aashray Care Home, Jaipur	SDG-2 & SDG-3
Jeevan Jyoti Old Age Home, Jaipur	SDG-2 & SDG-3
Matra Chaya Bal Grah, Vaishali Nagar, Jaipur	SDG-1, SDG-2 & SDG-3
JANKALA SAHITYA MANCH SANSTHAN, JAIPUR	SDG-11
JoJo International & IAESTE	SDG-4, SDG-9
Yuvaa and Maybelline	SDG-9, SDG-11 & SDG-16
Mahila Housing SEWA Trust, Ahmedabad	
Rotary Club Bapu Nagar	
Jain Social Group(Central) Sanshta Jaipur	
S K Soni Blood Centre Jaipur	

List of Local school involved in SDG dialogues:

HERITAGE GIRLS SCHOOL, EKLINGI, UDAIPUR	SDG-4
DPS GHAZIABAD DEHRADUN	SDG-4 & SDG-12
KESAV GLOBAL SCHOOL	SDG-4, &

Mahatma Gandhi Govt School Ganpatpura, Sanganer	SDG-4 &
New Indian Public School,Bagru.	SDG-4 &
Xaviers School Phulera	SDG-4 &
NSS & Nehru Children Secondary School, Dehmi Kalan	SDG-4 &
Cambridge court school	SDG-4 &
Amity School of Applied Sciences, Gurugram, Haryana, India	SDG-4 &
RVS Chennai Padmavathy School of Architecture, Chennai, Tamilnadu	SDG-4 &

List of Government / Non-Government organization involved in cross-sectoral dialogue about the SDGs:

RAJASTHAN INTERNATIONA L CENTER DRONAH Foundation	SDG-11
Mahatma Gandhi Medical College and Hospital, Mahatma Gandhi University of Medical Sciences,RIICO Institutional Area,Tonk Road	SDG-3
Indian Society for Training & Development (ISTD)	SDG-4 & SDG-9
Regional Centre for Biotechnology	SDG-4 & SDG-12
Rajiv Gandhi Centre of Advanced Technology (R-CAT)	SDG-11

Indian Institute of Arbitration & Mediation, India	SDG-16
Village Square	SDG-11
Indian Chemical Council	SDG-4 & SDG-3
Institute of Nano Science and Technology, Mohali	SDG-9
Konkan Bamboo & Cane Development Centre (KonBAC)	SDG-15
Semi-Conductor Laboratory, Department of Space	SDG-9 & SDG-11
Ranka Public Charitable Trust	SDG-16
NIMS Hospital, Jaipur	SDG-16
Bhargava Psychiatric Hospital	SDG-3

List of Conferences contributing for SDGs:

1. International Conference on WORLD SUMMIT – THE CONSTITUTIONAL RULE OF LAW, THE NEW SOCIAL RIGHTS, THE FUTURE OF FUNDAMENTAL RIGHTS JUNE 29-30, SANTA CATAWRINA, BRAZIL
2. WORLD CONFERENCE ON DIGITAL ENVIRONMENTS, NEW TRENDS IN SOCIAL NETWORKS AND THE END OF PASSWORDS AUGUST 29, 30, 31, 2023 – LONDRINA, BRAZIL
3. International Conference on Sustainable Development for Heritage and Built Environment
4. 24th Rubber Conference & Expo on Sustainability & Circular Economy.
5. 4th international conference on Smart System and Computing.

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8	In Silico Identification, Design And	Indian Council Of Medical Research ,New Delhi	Dr Sandeep Kumar Srivastava	SDG-12, SDG 9 & SDG 13

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Table 1. List of waste resources used as substrates for cost-effective bioplastic production

S. No.	Waste carbon source	Microorganisms	Cultivation technique	Maximum biomass production	Biobased plastic produced	Maximum production	References
1	Mixture of crude and saponified SCG oil	*Cupriavidus necator* DSM 545	Shake flask technique	8.5 g/L	Polyhydroxyalkanoate (PHA)	84.4% (w/w)	(Ingram, Martin and Winterburn, 2022)
2	Nitrogen-deficient cheese whey mother liquor	*Paracoccus homiensis*	Shake flask technique	3.3 g/L	Poly (3-hydroxybutyrate-co-3-hydroxyvalerate) P(3HB-co-3HV)	1.1 g/ L	(Mozejko-Ciesielska *et al.*, 2022)
3	Fermented concentrated cheese whey permeates	Mixed microbial culture (MMC)	Sequencing batch reactor	-	PHA	62% g PHA/ g VSS	(Colombo *et al.*, 2019)
4	Fermented secondary cheese whey			-		55.1% g PHA/ g VSS	
5	Digestate of chicken manure with sunflower frying oil	*Cupriavidus necator* H16	Shake flask technique	75.1 % cell dry mass	PHA	4.6 g/ L	(Altun, 2019)
6	Waste frying oil with 40 g/ L NaCl	*Halomonas hydrothermalis*	Shake flask technique	3.64 g/ L	Polyhydroxybutyrate (PHB)	2.26 g/ L	(Pernicova *et al.*, 2019)
7	Onion peel	*Bacillus siamensis* PD-A10	Shake flask technique	90.86 g/ L	PHA	67.56 g/L	(Vijay and Tarika, 2019)
8	Paper industry effluent	*Ancylobacter aquaticus*	Shake flask technique	-	PHA	41.7% w/w	(Tyagi and Sharma, 2021)
9	Beer brewery wastewater	*Cupriavidus necator*	Batch system	7.90 g/ L	PHB	3 g/ L	(Amini *et al.*, 2020)
10	Candy industry wastewater	*Cupriavidus necator* H16	Flask culture	1.11 g/ L	PHB/ Polylactic acid (PLA)	65% (w/w)	(Hernández-Herreros *et al.*, 2024)
11	Digested sludge	*Rhodopseudomonas* sp. S16-VOGS3	Photobioreactor	0.37 g/ L	PHB	18.5 mg/ L	(Touloupakis *et al.*, 2023)
12	Olive mill wastewater	*Rhodopseudomonas* sp. S16-FVPT5	Tube culture	0.13 g/ L	PHB	101 mg/ L	(Carlozzi *et al.*, 2019)

3. Objectives

- Design a novel cost-effective artificial media mimicking seawater and optimize the parameters for the growth of *R. palustris.*
- Optimize culture conditions for high PHA production under different sets of nutrients limiting and stress conditions.
- Screen and qualitatively characterize the PHA granules via staining and microscopy and quantify the percentage of PHA accumulation.
- Augment the extraction of PHA from cell biomass and analyse its molecular structure.

4. Methodology:

The *Rhodopseudomonas palustris* MDOC01 strain, isolated in our lab from dairy waste, was cultured in a synthetic medium called Designed Synthetic Water Medium (DSWM) containing minerals along with glycerol and monosodium glutamate as carbon and nitrogen sources. The cells were grown in 500 ml glass bottles with Q series GL45 caps for sampling and argon gas purging to maintain an anoxic environment. The cultures were kept at 30-35°C with continuous stirring at 500 rpm and 4000 lux light from 60 W incandescent bulbs (Syed, Sogani, Kumar, *et al.*, 2022). Figure 1 describes the detailed methodology followed during the work

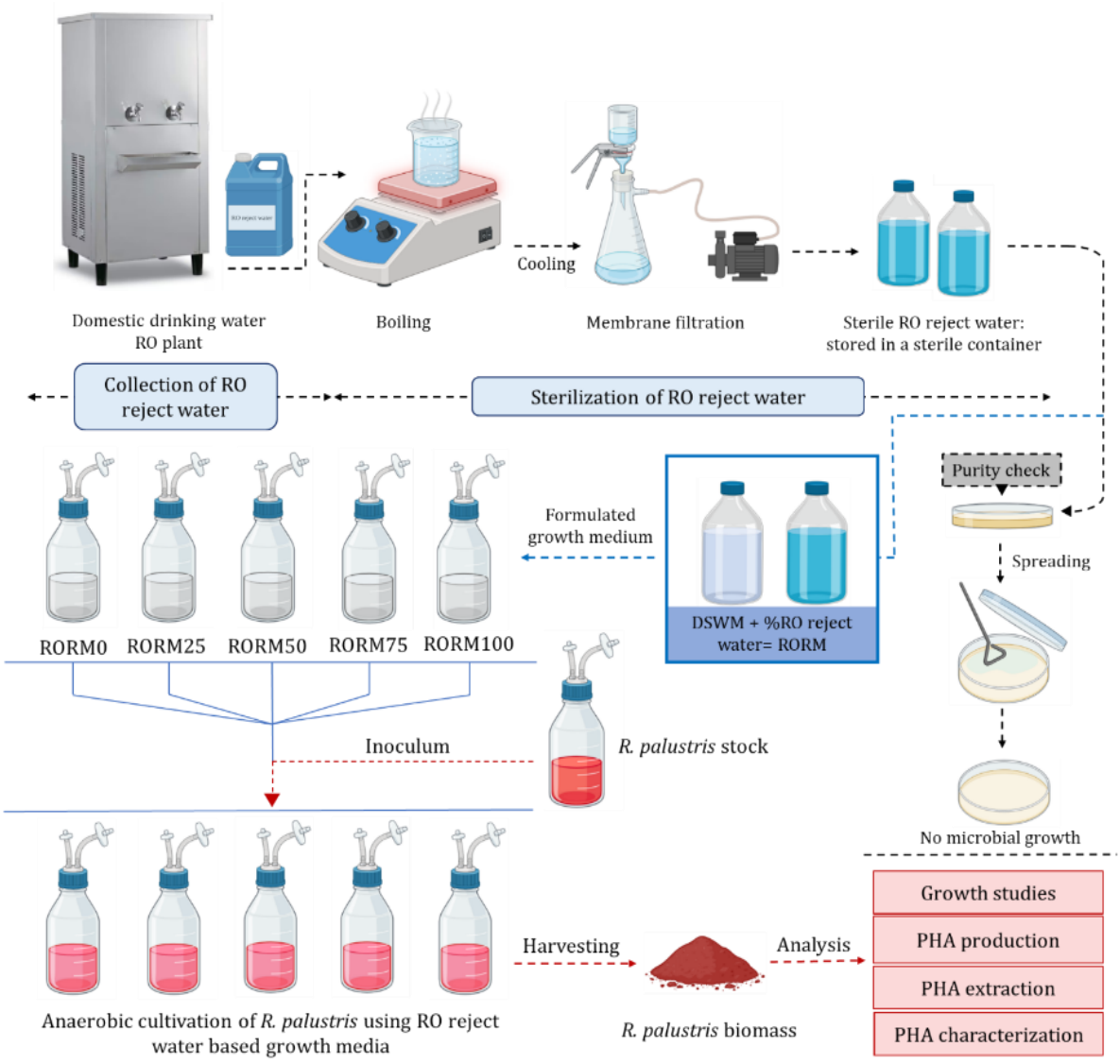

Figure 1. Detailed methodology of the research work

5. Results and discussion:

OBJECTIVE 1

Collection of RO reject water: The reject water coming from a domestic drinking water RO plant has a consistent nutrient and pathogen-free composition (Bhandari and Prajapati, 2022b). RO reject water, collected from a drinking water RO plant, located at Bagru, Rajasthan, was used to develop a novel cost-effective growth media for *R. palustris* culturing. Initially, the water was subjected to physicochemical analysis to determine its composition and suitability as a growth medium. Table 2 reveals that upon comparison with DSWM, the RO reject water was found to be very similar in the ionic and mineral composition to the DSWM. This, in addition to the metabolic adaptability of *R. palustris,* supports RO reject water as a cost-effective growth medium.

Table 2. Physicochemical analysis of the RO reject water

Parameters	Results
pH	7.9
TDS (ppm)	1318
Electrical conductivity (µS cm^{-1})	2636
Salinity (PSU)	1.34
Alkalinity (mg L^{-1})	258.5
Total hardness (mg L^{-1} as $CaCO_3$)	82.9
Chloride (mg L^{-1})	409
Sodium (mg L^{-1})	265.75
Potassium (mg L^{-1})	6.32
Nitrate nitrogen (ppm)	16.6
Nitrite (ppb)	2.0
Calcium (ppm)	200
Magnesium (ppm)	1000
Ammonical nitrogen (mg L^{-1})	<2.0
Ammonia (ppm)	0.06
Phosphate (ppm)	0.90
Phosphorus (mg L^{-1})	<0.50
Sulphate (mg L^{-1})	54.8
Fluoride (mg L^{-1})	<0.05
Iron (mg L^{-1})	<0.1

As the work was on pure microbial strain, the RO reject water was first subjected to sterilization via boiling followed by filtration. The sterility was confirmed by the spread plate technique and no microbial growth was observed within 24-48 hours of incubation. Further, the RO reject water was provided with glycerol and sodium glutamate as carbon and nitrogen sources, forming RO Reject water Medium (RORM). This, in addition to the metabolic adaptability of *R. palustris,* supports RO reject water as a cost-effective growth medium.

Suitability of RORM as a growth medium for *R. palustris* in terms of biomass and bacteriochlorophyll *a* (Bchl *a*) yields (Syed, Sogani, Sharma, *et al.*, 2022)**:** For this, the sterile RO reject water was mixed with different concentrations of DSWM (RORM0 (Positive control), RORM25, RORM50, RORM75, RORM100) and the N: C ratio of 5.4 mM: 10 mM was made consistent in all media sets (Sogani *et al.*, 2020). During 10 days of growth, RORM75 showed good biomass and Bchl *a* concentration and productivity (Biomass: 1.75 g L^{-1}; 92.44 mg L^{-1} d^{-1}; Bchl *a*: 15.10 mg L^{-1}; 1.223 mg L^{-1} d^{-1}), comparable to the control (RORM0; 2.0 g L^{-1}, 148.8 mg L^{-1} d^{-1}).

Microscopic analysis of *R. palustris* in RORM75: Scanning Electron Microscopy (SEM) was used to observe the morphology of *R. palustris*. As illustrated in Figure 2, no significant morphological differences were observed between the cells grown in RORM75 and DSWM (control). This finding suggests that RORM75 does not substantially alter the cell morphology, which is a positive indication regarding its impact on *R. palustris*.

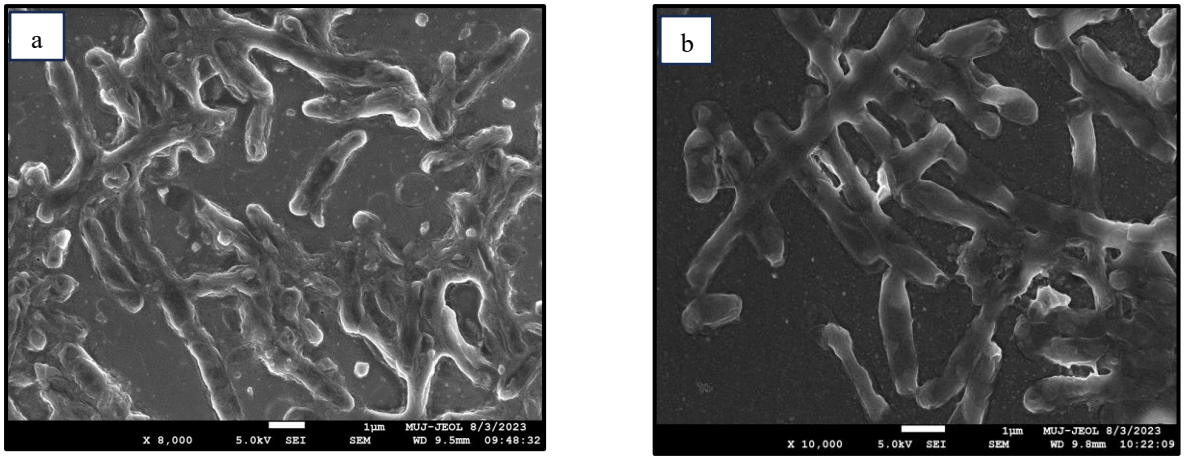

Figure 2. SEM images of *R. palustris* cells grown in (a) DSWM and (b) RORM75

Deliverables:

- RO reject water stream, otherwise discarded and not managed properly, can be repurposed for microbial cultivation for high biomass yield, hence suggesting an environmentally sustainable approach for RO reject water recycling.
- With appropriate adjustments, RORM75 offers both environmental and economic advantages for *R. palustris* cultivation, by replacing expensive nutrients present in the conventional growth media.

OBJECTIVE 2:

Production of PHA under PHA-producing culture conditions: As reported earlier, PHAs are produced by microbial cells under stress conditions (e.g. Nutrient limitation) and high carbon concentration in the form of energy and carbon storage granules (Mannina *et al.*, 2020)**.** The present work used the concept of feast and famine conditions for microbial PHA production. In the feast phase, *R. palustris* was provided with abundant nutrients for maximum growth and then subjected to the famine phase with limited nutrients for PHA production. As RORM75 showed the maximum biomass, it was taken further for PHA production along with RORM0 and RORM100. Figure 3 shows the culture conditions for PHA production from *R. palustris.*

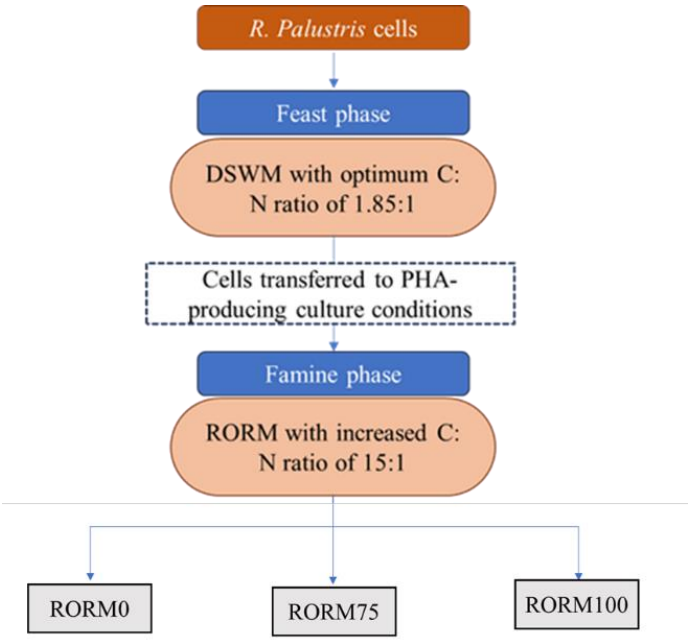

Figure 3. Various culture conditions for PHA production from *R. palustris*

After 7 days of the famine phase, PHA was extracted using the hypochlorite method, and the percent PHA of cell dry weight (CDW) was calculated in each condition (Marudkla *et al.*, 2018). Figure 4 depicts the white-colored PHA extracted from *R. palustris* from RORM75 with a C: N ratio of 15:1 and Table 3 shows the PHA yield

obtained in each culture condition and it can be concluded that RORM75 with a C: N ratio of 15:1 yielded the maximum PHA of 130 % CDW.

Figure 4. PHA extracted from *R. palustris* cultured in RORM75 with C: N= 15:1

Table 3. Amount of PHA obtained from *R. palustris* in various culture conditions

S. No	Culture conditions with C: N= 15:1	Amount (mg)	% PHA of CDW
1	RORM0	196	10.6
2	RORM75	1336	130
3	RORM100	27	2.4

Deliverables:

- The most suitable combination of feast and famine phases for high PHA production from *R. palustris* is DSWM with an optimum C: N ratio as the feast phase and RORM75 with a high C: N ratio of 15:1 as the famine phase.

OBJECTIVE 3 and OBJECTIVE 4

Characterization of the extracted PHA: The extracted PHA was subjected to Fourier Transform Infrared Spectroscopy (FTIR) and Proton Nuclear Magnetic Resonance (^{1}HNMR) analysis for its chemical and molecular characterization (El-Kadi *et al.*, 2021). Figures 5 and 6 show the FTIR and ^{1}HNMR spectra of PHA extracted from RORM75 and the standard PHA obtained from Sigma Aldrich.

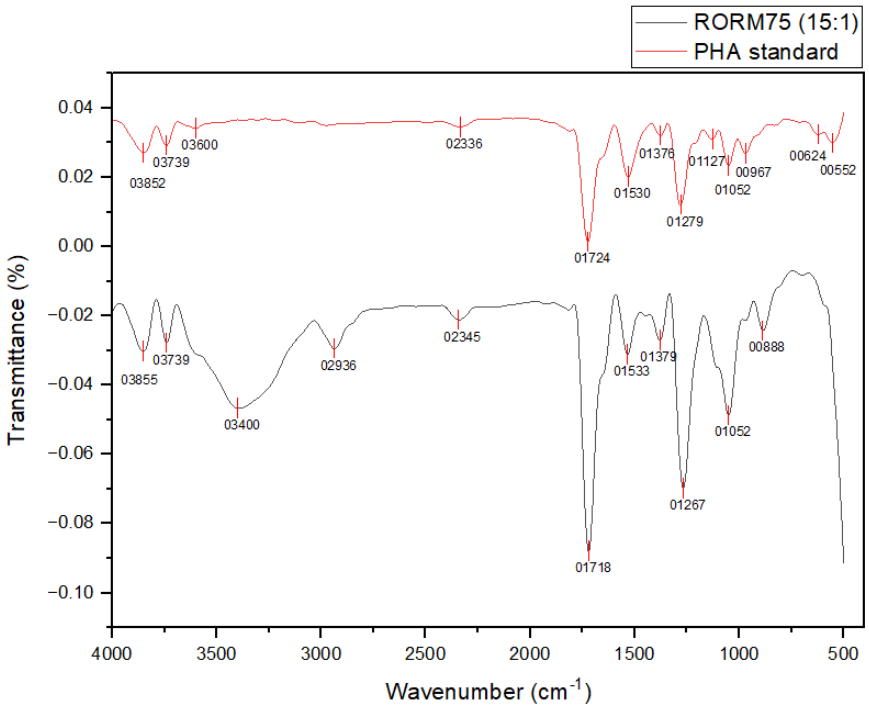

Figure 5. FTIR spectra of PHA extracted from RORM75 and the standard PHA obtained from Sigma Aldrich

PHA was characterized in the range of 500–4000 cm^{-1}. A broad and weak band around 3600 cm^{-1} in the standard indicates O-H stretching, showing the presence of hydroxyl groups like alcohols or carboxylic groups. A similar but less prominent band is seen around 3700–3600 cm^{-1} in the case of PHA extracted from RORM75 (15:1), The O-H or N-H stretching is seen in both the cases but the intensity in PHA extracted from RORM75 (15:1) is weaker, possibly due to lower concentration or interaction of the hydroxyl groups. A sharp and intense peak at 1724 cm^{-1} in standard PHA might indicate strong C=O stretching, which is typical for esters or carboxylic acids. This is a defining feature of PHA, which contains ester bonds. PHA from RORM75 (15:1) also has strong C=O peaks, but it is slightly shifted (1718 cm^{-1}) which may reflect different carbonyl environments or interactions with other groups. Peaks at 1376 cm^{-1} and 1279 cm^{-1}, correspond to C-H bending and C-O stretching in esters in the standard. Similar peaks are present but with some shifts in the PHA extracted from RORM75 (15:1), such as peaks at 1379 cm^{-1} and 1267 cm^{-1}. This region may also show contributions from other functional groups. The fingerprint region which is unique to each compound, shows that PHA extracted from RORM75 (15:1) has structural differences compared to the PHA standard, likely due to differences in its polymeric structure or side chain composition.

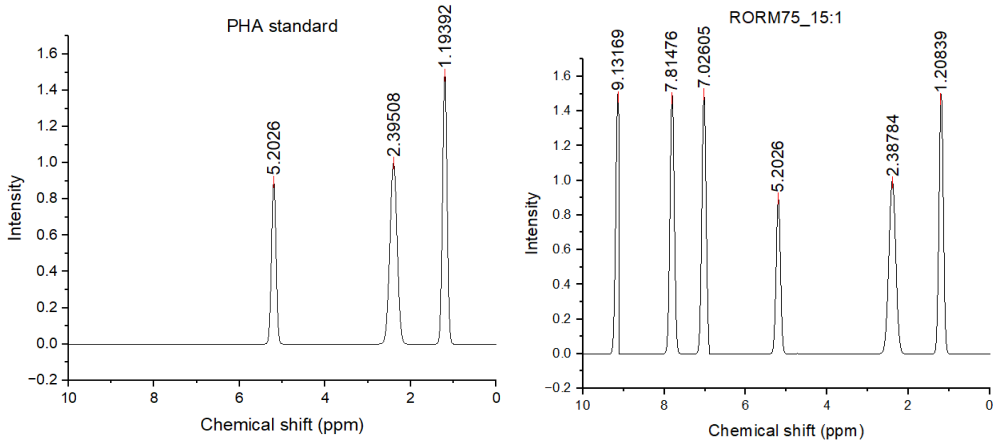

Figure 6: ^{1}HNMR spectra of PHA extracted from RORM75 (15:1) and the standard PHA obtained from Sigma Aldrich

The key observations from the spectra of standard PHA include a peak at 5.20 ppm showing the methine proton (-CH), attached to the carbonyl group in the polymer backbone, typical of PHA. This indicates an ester linkage where a proton is adjacent to a carbonyl group. Another peak at 2.39 ppm corresponds to methylene protons (-CH_2) adjacent to the carbonyl group in the PHA structure, again indicating ester functionality. Lastly, a peak at 1.19 ppm represents a methyl group (-CH_3) at the end of the alkyl chain, commonly found in PHAs where the chain ends with methyl groups. Comparing both spectrums, additional peaks at 9.13 ppm, 7.81 ppm, 7.02 ppm are unique to PHA extracted from RORM75 and absent in the PHA standard, suggesting the presence of aromatic groups, but the common peaks at 5.20 ppm, 2.38 ppm, and 1.20 ppm, in the spectrum of PHA obtained from RORM75 (15:1) are comparable to the standard and indicates that both materials contain ester groups (C=O) and aliphatic chains.

Deliverables:

- FTIR: PHA extracted from RORM75 (15:1) appears to share a similar backbone to PHA but with structural variations, possibly due to the presence of different side groups, chain lengths, or copolymer compositions.
- ^{1}HNMR: The PHA produced by *R. palustris* in RORM75 (15:1) is a modified version of the PHA, containing the same core ester and aliphatic groups as the PHA standard, but with significant modifications involving the addition of aromatic components.

6. Conclusion:

RO reject water can be used as a growth medium for cost-effective culturing and high biomass production of *R. palustris*.This concept not only makes the process of microbial cultivation economical but also provides an environmentally sustainable and safe approach for RO reject water management, thus avoiding environmental issues like groundwater and soil contamination caused by its current improper management strategies. Further, in the study, *R. palustris* stands out as an efficient microbial system for high PHA production, using RO reject water for the famine phase, thus also suggesting an approach for large-scale cost-effective production of PHA from *R. palustris*. The present study addresses various environmental issues, including improper RO reject water management, huge freshwater and expensive nutrient demand for high microbial biomass production, and plastic

pollution caused by the increased use of petro-based plastic materials. Moreover, a switch from using nonrenewable resources to renewable ones for developing materials like plastics would also help in dealing with climate change mitigation. Overall, the study focuses on exploiting the possible benefits of versatile microbes like *R. palustris* in maintaining the quality, health, and sustainability of the environment.

Outcomes:

Journal publications

- Rajvanshi, J., **Sogani, M.**, Kumar, A., Arora, S., Syed, Z., Sonu, K., Gupta, N.S. and Kalra, A., 2023. Perceiving biobased plastics as an alternative and innovative solution to combat plastic pollution for a circular economy. *Science of The Total Environment*, *874*, p.162441; (Q1, Impact factor: 8.2)
- Rajvanshi, J., **Sogani, M.**, Tziouvaras, G., Kumar, A., Syed, Z., Sonu, K., Gupta, N.S. and Sen, H., 2024. An analytical review on revamping plastic waste management: exploring recycling, biodegradation, and the growing role of biobased plastics. *Environmental Science and Pollution Research*, pp.1-19; (Q1, Impact factor: 5.8)
- Rajvanshi, J., **Sogani, M.**, Kumar, A. and Arora, S., 2023. Biomaterials: A Sustainable Solution for a Circular Economy. *Engineering Proceedings*, *59*(1), p.133; (SCOPUS Indexed conference proceeding).

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MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

Role in Supporting Local Government with Climate Change Disaster Early Warning and Monitoring

Manipal University Jaipur (MUJ) is actively engaged in supporting local and regional governments in managing climate change-related disasters and risks through early warning systems and continuous monitoring. With the increasing frequency and intensity of climate disasters, MUJ recognizes the importance of timely information, collaboration, and proactive measures to safeguard the local community from the impacts of climate change. Through its academic expertise, research capabilities, and technological resources, MUJ plays a vital role in informing local authorities and enhancing early warning mechanisms for climate-related events.

MUJ conducts extensive research in environmental science, climate studies, and disaster management, focusing on the local and regional impacts of climate change. The university shares this data with local and regional governments to help them better understand climate risks such as rising temperatures, changing rainfall patterns, and extreme weather events like floods and droughts. MUJ's research contributes to local government's disaster preparedness plans by providing valuable insights into risk-prone areas and future climate trends. MUJ leverages its technological expertise to assist local governments in developing and refining early warning systems for climate disasters. The university's departments of engineering and information technology collaborate on projects that involve real-time monitoring of weather patterns, atmospheric changes, and environmental conditions. By utilizing sensors, satellite data, and advanced software, MUJ helps establish systems that detect potential risks early, allowing local governments to issue timely alerts and take preventive measures. As part of its contribution to climate disaster monitoring, MUJ engages in climate risk mapping. By analyzing data on local geographical and climatic conditions, the university identifies areas that are most vulnerable to climate-induced disasters, such as flood-prone zones or regions susceptible to drought. These maps are shared with local authorities and used to develop targeted disaster preparedness strategies, ensuring that vulnerable communities receive adequate protection and support during emergencies. MUJ operates environmental monitoring systems that track key indicators such as air and water quality, temperature changes, and rainfall levels. This real-time monitoring provides continuous data that is shared with local governments for use in their disaster preparedness and risk management efforts. By maintaining a consistent flow of information, MUJ supports local authorities in making informed decisions to mitigate the effects of climate-related risks. In collaboration with local governments, MUJ runs public awareness campaigns that educate the local population about climate change risks and the importance of early warning systems. These campaigns teach residents how to interpret disaster warnings, prepare for potential emergencies, and adopt sustainable practices that reduce climate risks. By fostering a culture of preparedness, MUJ helps create a community that is more resilient and responsive to climate change challenges. MUJ serves as a bridge between the government and the community in disaster preparedness efforts. The university facilitates regular meetings

and workshops that bring together local authorities, community leaders, and disaster management experts to discuss ongoing climate challenges and improve coordination. This cooperative platform ensures that early warning messages reach the community efficiently and that there is a well-established communication network for disaster response. MUJ's expertise in climate science and disaster management enables the university to provide policy recommendations to local governments. These recommendations focus on improving early warning systems, updating infrastructure to withstand extreme weather events, and integrating climate change adaptation strategies into urban planning. MUJ's research-based insights ensure that local governments adopt policies that enhance long-term climate resilience and reduce the vulnerability of their populations to future climate risks.