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Biodegradation of low-density polyethylene by *Streptomyces albogriseolus* UPA11 isolated from a plastic dumpsite

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Abstract

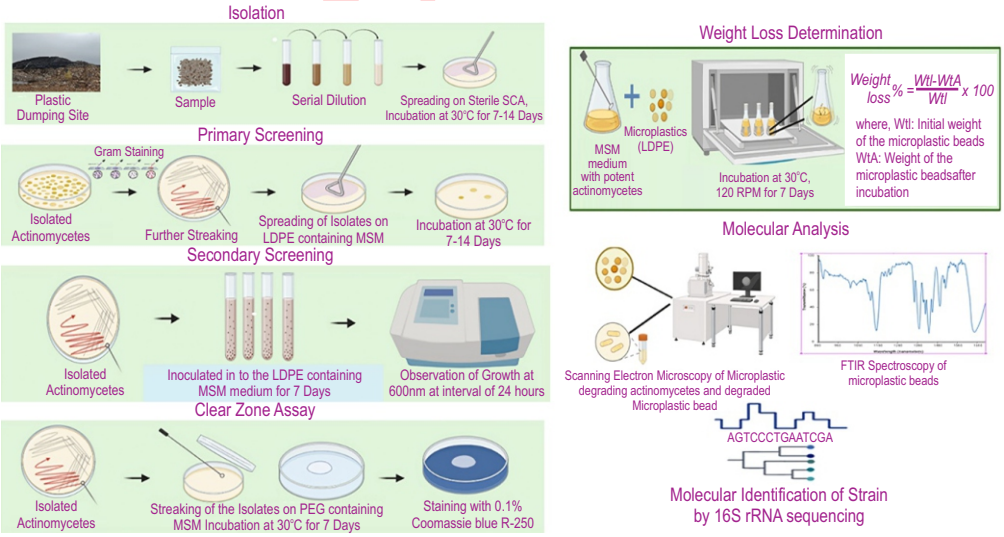
Aim: This study focused on isolating and identifying actinomycetes that degrade low-density polyethylene microplastics.

Methodology: For primary screening, low-density polyethylene (LDPE) powder was used with minimal salt medium, followed by growth analysis and clear zone tests to confirm plastic decomposition, and weight loss of microplastic beads with actinomycetes determined degradation after a month of incubation, which was validated using SEM and FTIR.

Results: A total of 47 isolates were isolated from several plastic disposal sites located in Rajkot, Gujarat. The results showed that 12 of the 47 isolates were able to generate a zone of clearing and breakdown of LDPE microplastic. Microplastic degradation was most apparent in UPA 11strain (10.1% + 0.6%), as validated by surface modification of the microplastic beads using SEM. Furthermore, 16S RNA sequencing on UPA 11 identified the isolate as *Streptomyces albogriseolus* (OR554013). The presence of phenolic group (O-H) was determined by a new peak between 947.33 and 1219.83 cm-1 using FTIR.

Interpretation: The study demonstrated the potential of UPA 11, to degrade low-density polyethylene microplastics under laboratory conditions. These findings underscore the potential of UPA 11 for bioremediation of plastic waste, offering an eco-friendly alternative to conventional plastic disposal methods.

Key words: Actinomycetes, Biodegradation, Dumping sites, Low-density polyethylene, Microplastic, *Streptomyces albogriseolus*



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Introduction

The demand for plastic production has significantly increased due to rising population since the early 1900s and now surpasses 390.7 million tons annually (Hassen *et al.,* 2025). Plastics are widely used due to low cost, high adaptability and durability, however, as they are non non-biodegradable with limited disposal sources they are accumulate in the environment adversly affecting the ecosystem (Arpia *et al.,* 2021). A total of 79% of left over plastics are disposed off in the environment, which is deleterious to living organisms (Beaumont *et al.,* 2019). In addition to terrestrial and aquatic habitats, mountains, river sediments, and even the most isolated locations, like Antarctica, are all affected by plastic pollution (Gündoğdu *et al.,* 2021). In the environment, accumulated plastic undergoes biological and physical processes, including fragmentation, weathering, and microbial degradation, resulting in the formation of tiny plastic pieces known as microplastics (<5 mm diameter) (Arpia *et al.,* 2021; Dasgupta *et al.,* 2021; Huang *et al.,* 2021).

Microplastics are tiny particles that can be ingested by living organisms, causing negative health effects (Yu *et al*., 2021). Microplastics inhibit plant reproduction, seed germination, and affects the population dynamics and diversity of microorganisms in the soil ecosystems (Jiang *et al.*, 2019; Zang *et al.*, 2020). In addition, microplastics have been detected in human biological systems, including blood and placental tissues, indicating their ability to enter and accumulate in the human body through ingestion, inhalation, and trophic transfer (Leslie *et al*., 2022; Ragusa *et al.*, 2021; Zhou *et al.*, 2022). Current methods, such as physical and chemical treatments, for microplastic degradation are less effective due to the small size and extensive dispersion of microplastics in the environment. Microorganisms are diverse and adapt to complex and inert materials as carbon sources (Auta *et al.,* 2017). The unique metabolism and adaptive features of microbes result in the biodegradation of various complex polymers. Several studies have identified various microplastic-degrading bacteria such as *Bacillus cereus, Bacillus gottheilii, Pseudomonas, Alcaligenes faecalis*, and *Streptococcus* sp. (Arefian *et al.,* 2020; Auta *et al.,* 2017; Habib *et al.,* 2020; Tareen *et al.,* 2022). As saprophytes and producers of hydrolytic enzymes, Actinomycetes play an pivotal role in the degradation of complex polymers. Numerous studies have reported significant degradation of plastic polymers by Actinobacteria (Charnock, 2021; Shao *et al.,* 2019; Soud, 2019).

The physical characteristics, melting points, and uses of plastics vary greatly, all of which have an impact on how persistent and recyclable they are in the environment. In the United States, only 2–4% of low-density polyethylene (LDPE), with a density of 0.910–0.940 g cm^{-3} and a melting point of 105–115 °C, is recycled, leaving approximately 88–96% unrecovered. Harder plastic (0.93–0.97 g cm^{-3}, melting point ~131 °C), HDPE is used for pipes, bottles, and containers; although bottles reach 30–35% recycling, 65–82% remain unrecycled. Overall,10% of HDPE is recycled. Although polypropylene, which is robust and heat-resistant (0.855–0.946 g cm^{-3}, 160–170°C), is frequently used in textiles and food packaging, less than 3% of it is recycled, meaning that more than 88% of it is discarded. Less than 1% of polystyrene, a rigid, brittle material (1.04–1.10 g cm^{-3}, ~240 °C) used in insulation and disposable goods, is recycled. (Di *et al.,* 2021; Zhang *et al.,* 2021). Despite being durable and widely used in the construction (1.16–1.58 g cm^{-3}, variable melting point), polyvinyl chloride is rarely recycled (~0%), i.e., 100% is wasted. Among all plastics, it has the highest recycling rate of approximately 15% overall and 29–33% for bottles. However, 67–85% of the PET still remains untreated (Smith *et al*., 2022; Di *et al.*, 2021).

Despite the spread of non-recyclable low-density polyethylene (LDPE) microplastics in the environment and the limited success rates of current physical and chemical remediation techniques, this research aims to isolate, screen, and characterise actinomycetes with the potential to biodegrade LDPE microplastics. To the best of our knowledge, this is the first documented evidence of *Streptomyces albogriseolus* degrading LDPE microplastics. This research offers insightful information about the function of actinomycetes in the degradation of microplastics and may help identify particular enzymes and processes that open the door for long-term bioremediation techniques.

Materials and Methods

Sample collection: Microplastic-degrading actinomycetes were isolated from soil samples from two sampling sites, Rajkot Municipal Corporation and Aji dam dumping site in Rajkot Gujarat, India. Approximately, 20 g of soil samples were collected into sterile zip bags from a 3-5 cm depth of dumping sites.

Isolation of microplastic-degrading actinomycetes: Soil samples were air-dried at 70°C for 2 hrs to reduce bacterial contamination and enrich for actinomycete (Shirling and Gottlieb, 1966). Furthermore, 1 g of preheated samples were diluted in a series and spread onto sterile starch casein agar plates. The plates were incubated at 30°C for 7 days. Actinomycete colonies were identified by their characteristic morphological features and subcultured onto fresh starch-casein agar plates for further maintenance (Kuster and Williams, 1964).

Screening of isolates for plastic degradation: Primary screening of the isolates was done by spreading the actinomycetes on minimal salt medium (MSM) containing $NaNO_3$, $MgSO_4$, KCl, $FeSO_4$, KH_2PO_4, K_2HPO_4, Yeast extract and 1% LDPE powder as a sole source of carbon ((Esmaeili *et al*., 2013)). The pH of the medium was adjusted to 7. Secondary screening of the isolates was performed by measuring their growth at 600 nm in minimal salt broth containing 1% LDPE powder for 7 days (Auta *et al.,* 2017).

Clear zone assay: The isolates were screened for clear zones by inoculating them onto MSM containing 1% polyethylene glycol

(PEG). Following incubation, the plates were dyed with Coomassie Brilliant Blue prepared in 40% methanol and 20% acetic acid for 20 min. Staining was removed, and distaining was performed with 40% methanol and 20% acetic acid. The clear zone was observed in a blue background (Hadad *et al.,* 2005; Rana and Rana, 2020).

Morphological and biochemical: Morphological identification of actinomycetes and Gram staining were performed as per Lechevalier (1989). Methyl red test (MR), Voges-Proskauer test (VP), Indole, Citrate utilization, H_2S production, Starch hydrolysis, and Gelatine Hydrolysis, were performed for bacterial characterization as per standard methods (Williams *et al*., 1989).

Determination of microplastic degradation by weight loss: The Final biodegradation of microplastic was observed using the weight-loss method. The microplastic-degrading actinomycetes were inoculated into the MSM medium containing 1% microplastic beads for 30 days. After incubation, the microplastic beads were cleaned of cell debris with 70% ethanol and dried overnight. The final weight of the dried microplastic beads was measured, and the percent weight loss was determined by the formula given by Auta *et al.* (2017).

Molecular identification of potent strain: HiPurA Bacterial DNA Purification Spin Column Kit (MB505-250PR, HiMedia, India) was used to extract genomic DNA and verified by 1% agarose gel electrophoresis. The bacterial 16s rRNA gene was amplified via PCR with primers F27 and 1492R (Clarridge, 2004). PCR products were stained with GelRed and observed under UV light. The BigDye Terminator v.3.1 Cycle Sequencing Kit sequenced the purified PCR product. A phylogenetic tree was constructed using the neighbour-joining method in MEGA 11 (Tamura *et al.,* 2021).

SEM of degraded microplastic beads: The degradation and surface modifications of LDPE microplastic beads were observed by SEM. For SEM analysis the microplastic beads were cleaned with 95% ethanol to remove any remaining cells. Thereafter, dried and examined along with a control sample. The sample was examined at 2000X to 5000X magnification after being coated with a gold layer at 25mA in an argon (Ar) environment at 0.3 MPa (Auta *et al.,* 2018).

FTIR analysis of microplastic: The changes in the microplastic beads inoculated with potent actinomycetes UPA 11, along with an uninoculated control microplastic were analyzed by FTIR spectroscopy in the frequency range of 500 to 4000 cm^{-1} (Auta *et al.,* 2022).

Statistical analysis: The data were statistically analysed by ANOVA with Tukey's LSD test ($P < 0.05$) using XLSTAT software, followed by calculating standard deviation and standard error. Significance difference of each sample is annotated by letters in Fig.1, 2.

Results and Discussion

Sample collection was carried out from plastic dumping sites as it is consider as a good source for the isolation of plastic degrading bacteria (Kumar *et al*., 2021). A total of 47 actinomycetes were isolated, out of which 23 isolates were obtained from the (Rajkot Municipal Corporation) dumping site, while 19 isolates were isolated from the Aji Dam dumping site. Out of 47 isolates, 23 exhibited intense growth, 7 showed moderate growth, and 7 other isolates showed poor growth on LDPE-supplemented medium. The remaining 10 isolates failed to grow, indicating inability to utilize LDPE as a carbon source. As a result of primary screening, only 23 of 47 isolates grew rapidly on MSM media with LDPE, and these 23 were selected for secondary screening. Furthermore, the 23 isolates were cultured in minimal salt broth containing 1% LDPE powder. A total of 23 isolates were selected for secondary screening; of these, 12 isolates showed proper growth in plastic containing MSM (Fig. 2). Isolates PU 6 (0.321, $\pm$ 0.005), PU 9 (0.284, $\pm$ 0.006), PU 12 (0.300 $\pm$ 0.006), PU 17 (0.333, $\pm$ 0.004), PU 18 (0.307, $\pm$ 0.004), PU 22 (0.277, $\pm$

Fig. 1: Study area (a) RMC (Rajkot Municipal Corporation) garbage collection center and (a) Aji dam dumping site.

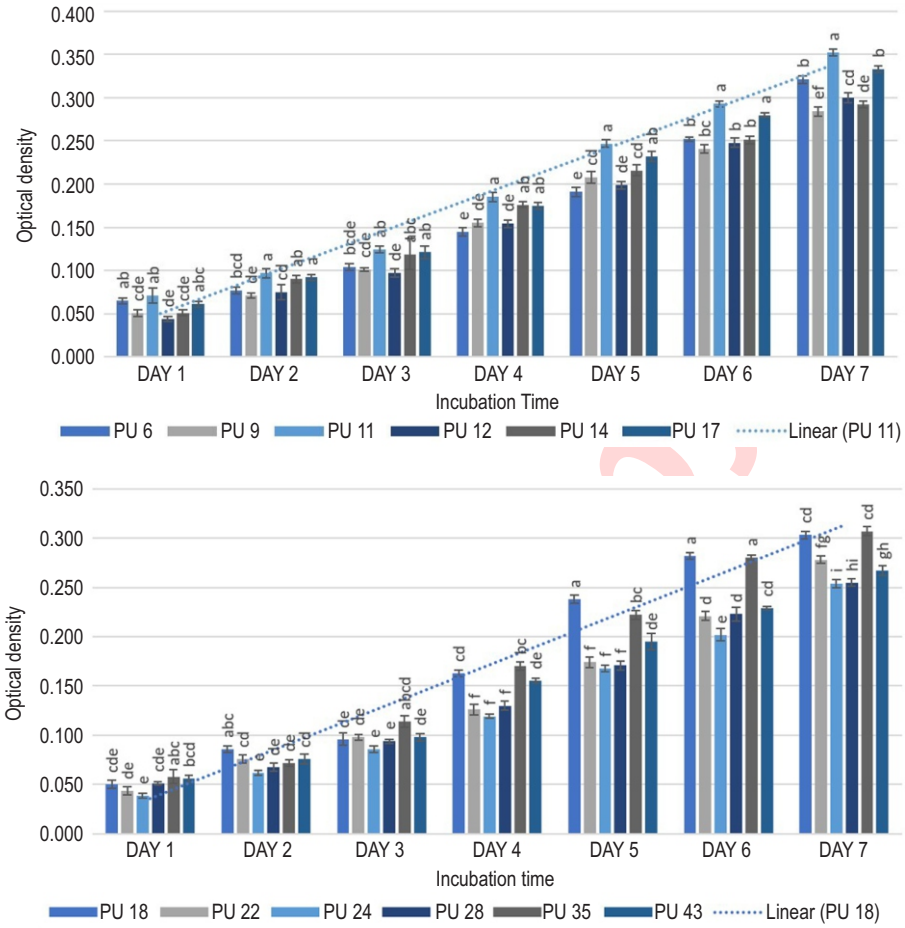

Fig. 2: Growth of isolates in LDPE containing minimal salt medium during 7 days of incubation; significant differences using Tukey's Test ($P < 0.05$) are shown by letters, the alphabets (a, b, c, d, e, f, g, h) indicate the degree of significance ($P < 0.05$) in descending order.

0.004), PU 43 (0.267, ± 0.005), PU 24 (0.254, ± 0.004), PU 28 (0.255, ± 0.004) and PU 35 (0.307, ± 0.005) exhibited higher O.D values at the end of the incubation period as compared to other isolates. Whereas, the maximum growth value was observed in UPA 11 (0.351, ± 0.004) on the 7th day of incubation.

Similar findings were reported by Soud (2019), where the growth O.D. was taken to evaluate LDPE degradation and identified *Streptomyces* spp. was identified as the most efficient degraders. In addition to *Streptomyces,* other actinomycetes such as *Rhodococcus ruber*, *Actinomadura* spp., and *Thermoactinomyces* spp. have also been recognized for their roles in plastic bioremediation (Amobonye *et al.,* 2020; Auta *et al.,* 2017; Jabloune *et al.,* 2020). The potent isolates that formed a zone of clearance on MSM were examined for morphological features and Gram staining. All the twelve isolates were Gram-positive. The majority of the isolates were myceloid (PU 6, UPA 11, and PU 18), with some being spherical and irregular. Actinomycetes are distinguished by their morphological characteristics, which include myceloid to irregular shapes, undulating and auriculate borders, and elevation of flat, umbonate, and elevated colonies. Majority of the colonies were found to be white followed by pink. further, after 72 hours of incubation, some colonies were observed to change pigmentation from white to grey. Similar pigmentation pattern were also observed in actinomycetes isolation from dumping site of Iraq (Soud, 2019). Twelve isolates that cleared the secondary screening showed effective LDPE degrading ability were selected for clear zone assay for the confirmation of low-density polyethylene degradation. The maximum zone of clearance was displayed by isolate UPA 11 (*Streptomyces albogriseolus*) (Fig. 3). The zone of clearance indicates the hydrolysis of plastic due to secretion of hydrolytic enzymes produced by the bacteria (Rajamanickam *et al.,* 2011). The clear zone formed by isolated actinomycetes UPA 11 (Fig. 3) indicates that the organism had utilized PEG till the formation of clear zone and it varied with organisms according to their degradation potential (Nakei *et al.,* 2022). All the ten actinomycetes were inoculated in sterile MSM containing 1 g of microplastic beads and incubated for 30 days. After incubation period, weight loss of microplastic beads was

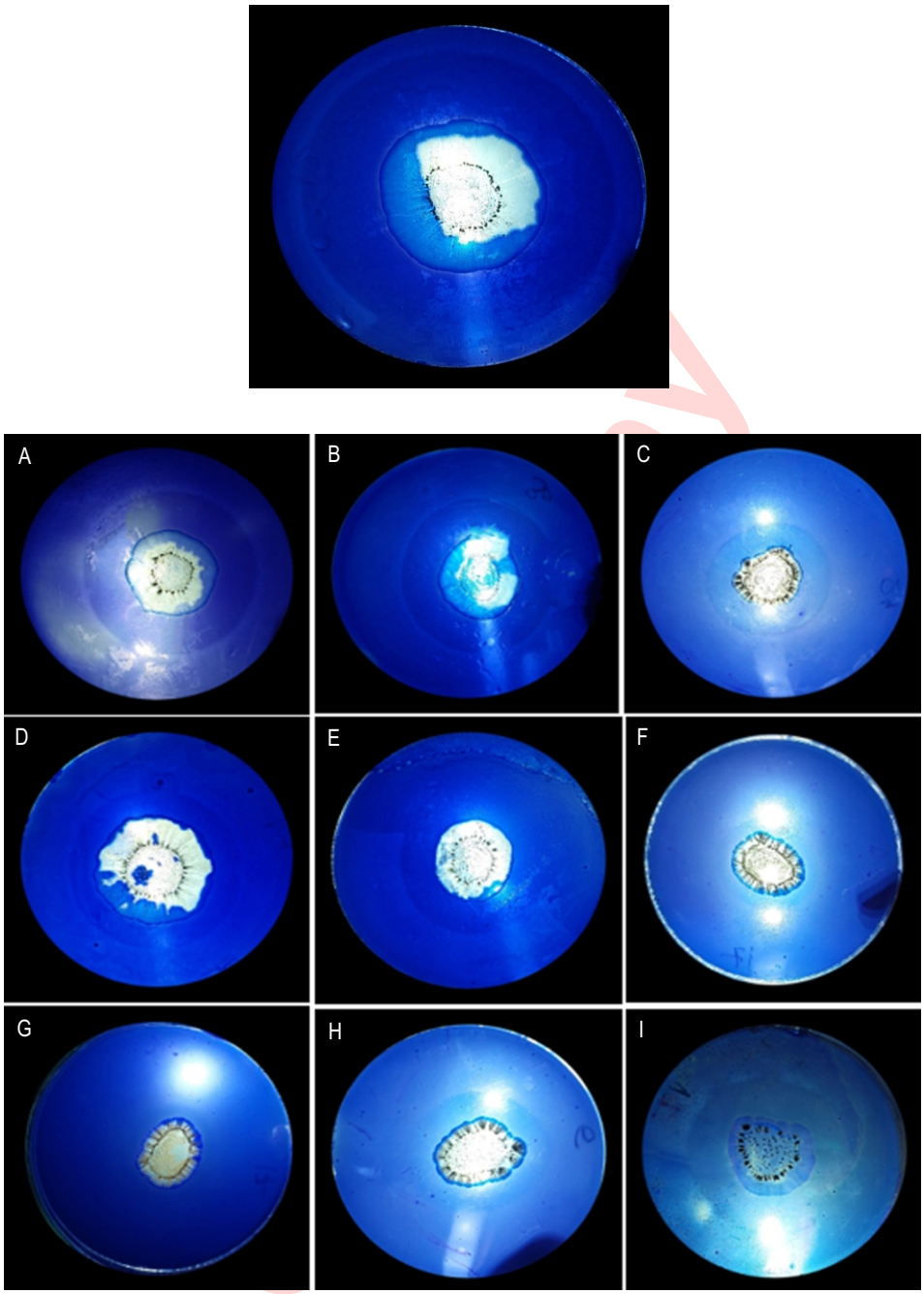

Fig. 3: Clear zone of UPA 11 (*Streptomyces albogriseolus*) on PEG containing MSM medium stained with Commasie brilliant blue after 7 days of incubation. A. PU12, B. PU43, C.PU6, D.PU17, E.PU30, F.PU18, G.PU22, H.PU24, I.PU28 on PEG containing MSM medium stained with Commasie brilliant blue after 7 days of incubation.

determined, the maximum degradation was observed in isolate UPA 11 (10.1 %, ± 0.6), followed by PU 12 (8.2 %, ± 0.5), PU 43 (8.1 %, ± 0.6), PU 6 (7.9 %, ± 0.5), PU 17 (6.8 %, ± 0.8), PU 30 (5.7 %, ± 0.5), PU 18 (4.4 %, ± 0.5), and PU 22 (4.3%, ± 0.4). Two isolates, PU 24 and PU 39, showed positive results in the clear zone assay; however, no significant weight loss of microplastics was observed in their case. These findings suggest that upon exposure to microplastics or their monomeric constituents, microbes can metabolize them as a carbon source. Prolonged interaction facilitates microbial adhesion to the microplastic surface, resulting in crack formation and surface alterations (Auta *et al.,* 2018; Soud, 2019). The degradation pattern observed in

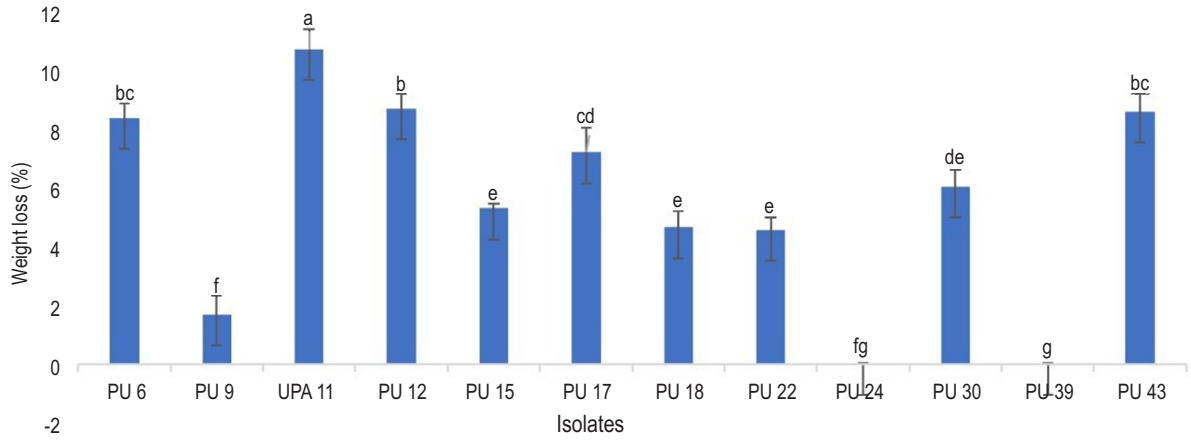

Fig. 4: Weight loss of microplastic beads treated with isolates after 30 days of incubation; Significant differences using Tukey's Test ($P < 0.05$) are shown by letters.

this study aligns with the previous reports of Habib *et al.* (2020) and Tareen *et al.* (2022), where *Pseudomonas* and *Rhodococcus* species degraded polypyrene microplastics, achieving weight reduction of 17.3% and 7.3%, respectively. Tareen *et al.* (2022) in their study reported high-density polyethylene microplastics and polyester microplastics degrading species, such as *Alcaligenes faecalis*, *Bacillus* spp., and *Streptococcus* spp. Due to variability in enzyme or metabolite production capable of breaking down microplastics, a wide range of weight-loss percentages was observed among the isolates, with some showing no detectable degradation (Shah *et al.,* 2008).

Despite shorter incubation period in the present study (30 days), the LDPE weight loss values obtained were noteworthy and demonstrated promising degradation potential. UPA 11 achieved 10.1% weight loss within a month, a performance that is already comparable to or exceeding many reported short-term results. For instance, *Streptomyces* sp. recorded 12.7% degradation in 30 days (Li *et al.,* 2022), *Rhodococcus ruber* C208 showed ~8–9% (Maleki Rad *et al.,* 2022), and *Nocardia* spp. reached 9.3% under similar conditions (Khandare *et al.,* 2021). Previous studies have reported plastic degradation by bacterial strains such as *Pseudomonas aeruginosa* V1 and *Bacillus subtilis* V8, which showed degradation efficiencies of 18.21% and 16.12% along with CO_2 emission values of 8.86 g l^{-1} and 8.10 g l^{-1}, respectively. However, these levels of degradation were achieved after a prolonged incubation period of 120 days (Pathak and Navneet, 2023). On the other hand, the efficiency of UPA 11 for the shorter duration is a promising candidate for fast degradation processes. Even under these extended conditions, *Acinetobacter calcoaceticus* V4, *Pseudomonas putida* C2-5, and *P. aminophilus* B14 recorded 15.44%, 13.30%, and 11.72% weight loss, respectively (Pathak and Navneet, 2023). Variations in LDPE form (microbeads vs. films) and culture parameters (Cao *et al.*, 2024) influence outcomes, indicating that UPA 11's potential may be even greater under optimized conditions.

The potent actinomycete isolate UPA 11, which demonstrated the highest biodegradative activity against microplastics, was subjected to biochemical characterization. The results showed that UPA 11 tested negative for Methyl Red, Voges-Proskauer, Indole production, and Urease activity, while it tested positive for citrate utilization, starch hydrolysis, and gelatin hydrolysis. The biochemical characteristics of UPA 11 are listed in Table 1. Isolate UPA 11 tested negative for Methyl red, Voges-Proskauer test, Indole, production and Urease activity, which signify the absence of mixed acid fermentation, production of acetoin, tryptophan and urease enzymes, respectively. The biochemical characteristics of isolate UPA 11 fit into the criteria of standard reported actinomycetes, which corroborates with the observations recorded by Vigneshwari *et al.* (2021). The isolate UPA 11 did not produce H_2S while inoculated in a TSI. Similar findings were reported by Baskaran *et al.* (2011), where actinomycetes isolated from mangrove sediments exhibited positive gelatin hydrolysis activity. The production of extracellular hydrolytic enzymes is a characteristic feature of actinomycetes and reflects their ability to degrade complex organic substrates present in the environment (Baskaran *et al.,* 2011).

The 16S RNA sequence of UPA 11 showed similarity with *Streptomyces albogriseolus* The identified sequence of UPA 11has been submitted to the gene bank with accession number OR554013. The phylogenetic relationship of the isolate is shown in Fig. 5. A similar actinomycete, *Streptomyces albogriseolus* strain LBX-2, was earlier isolated from the soils that showed significant changes in the surface morphology of polyethylene sheets (Shao *et al.,* 2019). This study reports LDPE microplastic degradation by *S. albogriseolus* UPA 11 through integrated surface, structural physico-chemical analyses. As compared to the work by Shao *et al.* (2019) which play emphasis on the genomic and mechanical evidence of polyethylene degradation, this study extends evidence to microplastic-scale substrates and brings into focus the relevance of *S. albogriseolus* in

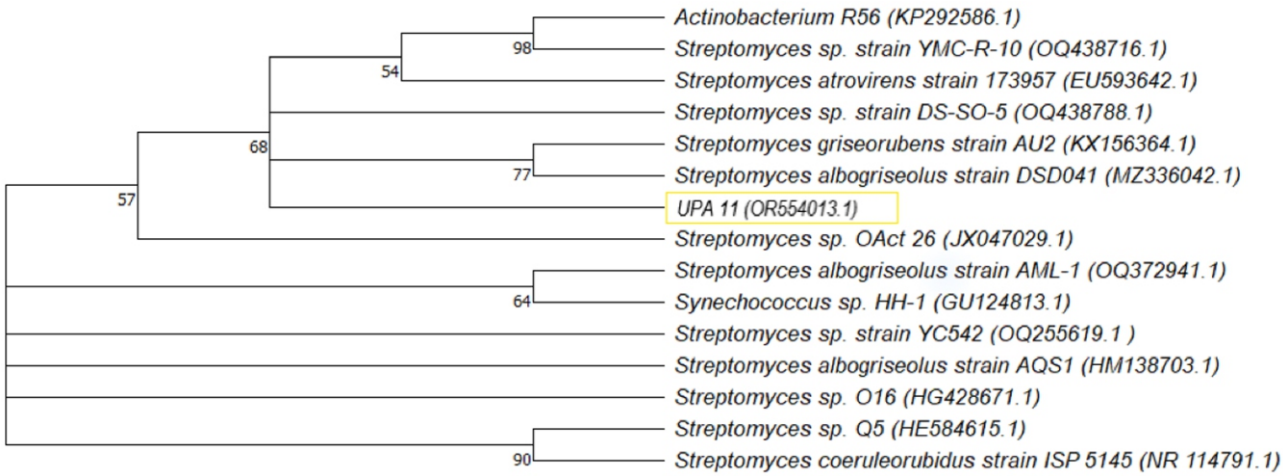

Fig. 5: Phylogenetic tree constructed using 16S rRNA gene sequences of UPA 11 and its closest phylogenetic relatives. The dendrogram was constructed using the Neighbor-Joining (Saitou and Nei, 1987) method in MEGA 11. Numbers at nodes represent bootstrap values (based on 1000 resamplings); GenBank accession numbers are shown in parentheses.

Table 1: Biochemical results of UPA 11 (*Streptomyces albogriseolus*)

Biochemical Test	Result
Methyl red	-
Vogus Pasteur	-
Indole	-
Citrate	+
Urease	-
H2S production	-
Starch hydrolysis	+
Gelatine hydrolysis	+

* - indicates negative results, + indicates positive results

environmentally realistic microplastic degradation. The scanning electron microscopy of the microplastic beads inoculated with potent actinomycetes was observed. The comparative figures of control microplastic beads and treated microplastic beads are shown in Fig. 6 (A and B). The SEM results demonstrated the morphological changes in the microplastic beads inoculated with UPA 11 (*Streptomyces albogriseolus*). The holes and cracks were also reported on the LDPE microplastic beads (Fig. 6 B). whereas control beads remained smooth and showed no surface modifications (Fig. 6 A). The SEM of UPA 11 (*Streptomyces albogriseolus*) revealed the details related to UPA 11 structure, which is shown in Fig. 6 C and D). The SEM images of *Streptomyces albogriseolus* revealed the chain arrangement of spherical-shaped spores with a smooth surface. Mycelium of the actinomycete UPA 11 is also visible in Fig. 6 (D), along with an attached spore at the top of the mycelium.

The genus *Streptomyces* is known for its well-developed mycelia and unique spore chain structures. Similar findings on morphological traits of *Streptomyces* species were reported earlier (Samundeeswari *et al*., 2012; Shao *et al*., 2019). Additionally, SEM analysis of LDPE microplastic beads treated with strain UPA11 revealed notable surface changes, including the development of pits, cracks, and irregular erosion patterns. The observed surface changes on polymer surface is a sign of degradation of microplastics (Auta *et al*., 2018; Zhang *et al*., 2019). Complex polymeric substrates *i.e*. polyethylene might have been broken down by Streptomyces sp. by secretion of variety of extracellular enzymes and oxidative metabolites. Therefore, may be able to start the biodegradation of microplastics based on the surface deterioration of LDPE microplastic beads (Auta *et al*., 2018; Zhang *et al*., 2019).

FTIR spectroscopy was conducted to examine the chemical alterations in LDPE microplastic. Control beads showed typical LDPE peaks at 717.83 cm^{-1} (C–H rocking) and 1462.32 cm^{-1} (C–H bending), and methylene stretching vibrations at 2846.43 and 2913.53 cm^{-1}, is in agreement with previously reported standard LDPE spectra (Pathak and Navneet, 2023; Li *et al.,* 2022). In comparison with the control, the results showed slight modification in the standard absorbance peaks at 717.55 cm^{-1}, 1471.41 cm^{-1}, 2846.70, and 2913.74 cm^{-1} (Fig. 7). New peak formation was also observed between 947.33 to 1219.83 cm^{-1} in the test beads inoculated with UPA 11 (*Streptomyces albogriseus*) after 30 days of incubation, which indicated the presence of phenolic groups (O-H).

Following treatment with UPA 11, small but reproducible peak shifts were detected C–H rocking from 717.83 to 717.55 cm^{-1}, C–H bending from 1462.32 to 1471.41 cm^{-1}, and methylene stretching from 2846.43/2913.53 to 2846.70/2913.74 cm^{-1}. Comparable small shifts in methylene vibration have also been noted in LDPE degradation by *Bacillus cereus* (Pathak and Navneet, 2023) and *Streptomyces* sp. (Li *et al.,* 2022), which

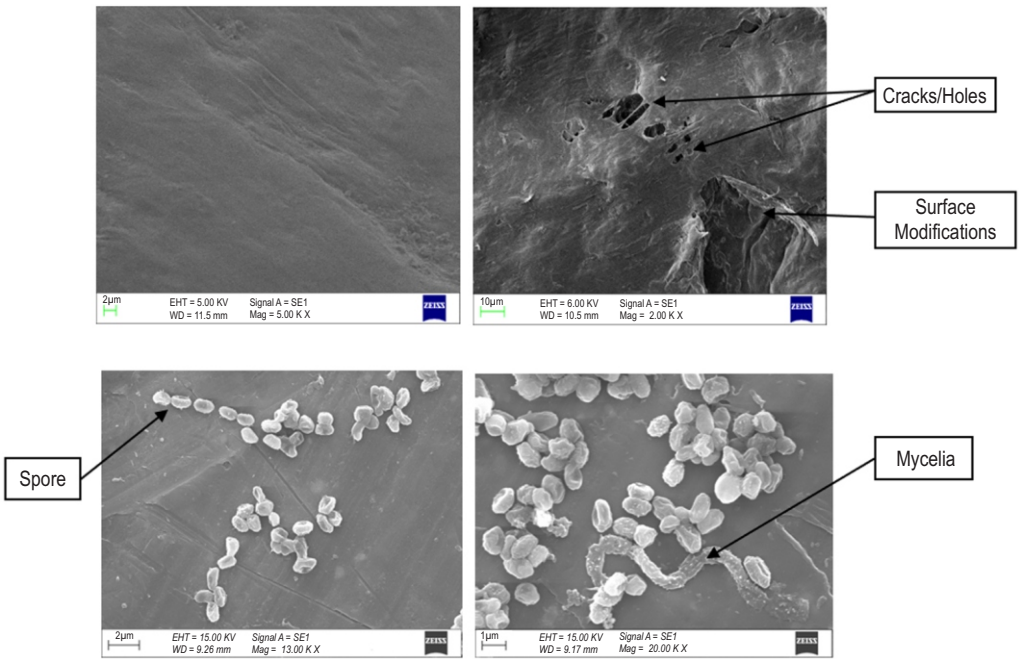

Fig. 6: SEM images of microplastic beads and isolated actinomycete UPA 11 (*Streptomyces albogriseolus*) (A). LDPE microplastic bead (Control) (B). LDPE microplastic beads inoculated with UPA 11 (*Streptomyces albogriseolus*) (C) and (D). UPA 11 (*Streptomyces albogriseolus*).

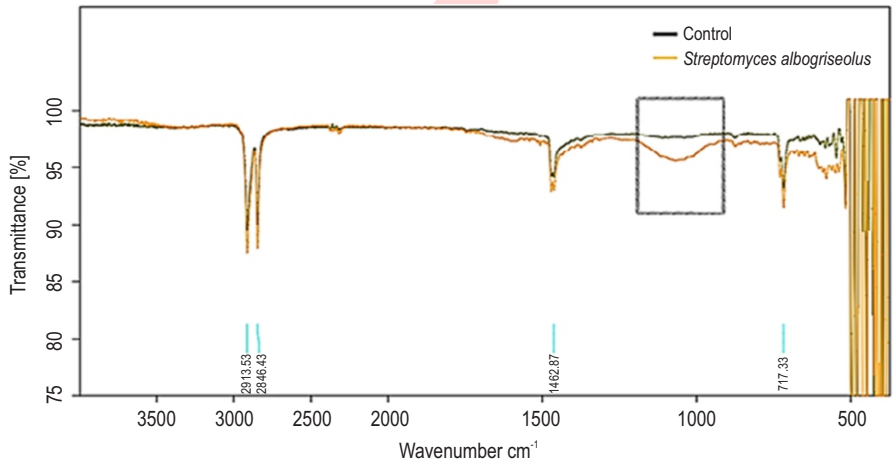

Fig. 7: Comparison of FTIR spectra of LDPE microplastic bead (Control) and LDPE microplastic bead inoculated with UPA 11 (*Streptomyces albogriseolus*) (Test).

were considered indicative of shifts in the chemical environment of the polymer backbone owing to oxidative or hydrolytic modification. The most distinctive change in the UPA 11 treated beads was the emergence of new peaks in the range of 947.33–1219.83 cm^{-1}, due to phenolic O–H stretching vibrations. Similar new absorptions in the range of 1000–1250 cm^{-1}, have been observed in *Streptomyces* sp. (Cao *et al.,* 2024) and *Nocardia* sp. (Khandare *et al.,* 2021), and they were ascribed to hydroxyl and ether group formation. Phenolic and other oxygenated functional groups are evidence of oxidative surface modification of LDPE. For example, *Pseudomonas putida* (Adithama *et al.,* 2023), as well as actinomycetes strains such as *Rhodococcus, Streptomyces*, and *Nocardia* (Soleimani *et al.,* 2021), also generated oxygen-containing functional groups, making the polymer more hydrophilic and allowing easier microbial colonization. Such functionalization has been proposed as a requirement for the enzymatic cleavage of C–C bonds in polyethylene chains (Ya *et al.,* 2022). Together, the FTIR spectral

alterations in this study small methylene peak shifts plus the advent of phenolic O–H absorptions are typical of oxidative degradation pathways reported previously (Adithama *et al.,* 2023; Soleimani *et al.,* 2021). Slight methylene peak shifts and the emergence of phenolic O-H absorptions provide evidence that *Streptomyces albogriseolus* UPA 11 indicates oxidative modification of LDPE microplastic beads within 30 days. These chemical changes suggest that UPA 11 can convert the hydrophobic polyethylene surface into a more hydrophilic, reactive substrate. They also align with early-stage biodegradation patterns reported for other high-performing bacterial and actinomycete strains. In conjunction with extended incubation or ideal culture conditions, this functionalization, which most likely signifies the initial stage of extensive polymer chain cleavage, may result in increased overall degradation efficiency.

In light of the above discussion, this research brings into focus the potential for the biodegradation of microplastics and the importance of dump sites as habitats for the microorganisms that have the capability to biodegrade microplastics. Based on the evidence, the paper indicates the capability of *Streptomyces albogriseolus* to break down LDPE microplastics, as well as the confirmation by SEM that the LDPE had degraded. It is conclusive to state that biodegradation is an important and sustainable means to reduce plastic and microplastic pollution.These results reinforced the concept of biodegradation and advanced toward a sustainable method for eliminating plastic and microplastic pollution. Actinomycetes serve as effective microplastic decomposers, and further investigation in this area may provide a significant solution for the removal of ubiquitous contaminant.

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