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Pre-Treated Pet Microplastics Biodegradation Products Identified by GCMS

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KEYWORDS:
GCMS, Biodegradation, PET microplastics

ABSTRACT:

Introduction: Our lives now cannot function without plastic, and completely reducing plastic usage is a challenging goal. Plastic is refractory and non-biodegradable, which causes tones of plastic waste to accumulate in landfills and waterways, threatening human health as well as marine life. Consequently, Microplastics have recently been considered as an emerging class of contaminants due to their ecotoxicological impact on the aquatic environment as well as soil matrix.

Objective: The objective of the present investigation is to use GC-MS and FTIR to assess the extent of Polyethylene terephthalate (PET) microplastics biodegradation.

Methods: PET Plastic degradation bacteria were isolation form old PET plastic waste surface and it was identified by 16s RNA methods. Biodegradation of pre-treated PET microplastics and without pre-treated PET microplastics incubated in MSM medium with bacteria. The by-product of biodegradation was analysis by GCMS methods from MSM medium after one incubation.

Result: When comparing UV light-treated PET microplastics to untreated PET microplastics after incubated with bacteria in MSM medium, we found by-products of hydrolysis such as diethyl phthalate, bis(2-ethylhexyl) phthalate and Bis(2-ethylhexyl) phthalate from UV-PETMP by GCMS. It could be a bacterial action on PET plastics. A potential partial solution to the prevalent planetary plastic accumulating is the use of bacterial consortia for PET biodegradation.

1. Introduction

Plastic first appear in the 1860s using synthetic organic polymers, namely fossil hydrocarbon derivatives. After the 1940s, plastic production became one of the fastest-growing worldwide businesses[1,2]. Plastic has grown in significance in today's world, making it an essential component of the textile, automobile industrial and packing sectors [3]. Plastic are in great demand because of their superior physical and chemical qualities, including lightweight, heat resistant and malleable. Plastics are highly valued for their transparency, hardness, and tensile strength, making them an attractive option form many different purpose[4]. The transition from reusable to single use containers contributes to the increased use of plastics in the packing industry[1]. Plastics strong features, formerly believed to be advantageous, are now causing a continuous increase in waste in both terrestrial and marine habitats[5]. Plastics, made from hydrocarbons produced from fossil fuels, can remain in the environment for up to 1000 years, making them a persistent substance [6]. Several types of plastic were using in the world, PETE (polyethylene terephthalate), a kind of polyester plastic, is one of the most widely used materials in beverage packaging. PET bottles have constantly risen in production and use for beverage packaging due to its outstanding transparency, light

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weight, gas and water barrier qualities, impact strength, and un-breakability (compared to glass bottles)[7]. PET materials are widely employed in a variety of applications, including clothing, home goods, hygiene, and medical textiles[8]. PET is widely used for packaging films, synthetic fibres, beverage and food bottles, and engineering plastic components because of its outstanding thermal and mechanical qualities, strong chemical resistance, and low gas permeability [9, 10]. The presence of PET in municipal solid waste has been increasing, and it causes plastic waste disposal problem as consumption increases dramatically. But recycling is a complex process as the materials are degraded during normal usage and by the recycling process [11]. These materials, due to high molecular weight and hydrophobicity, are resistant to environmental factors and after usage they become burdensome ballast to the environment [12].The abundant accumulation of PET waste is of environmental concern due to its non-biodegradability, which is a major obstacle for disposal of PET by conventional methods such as land filling and incineration. What is required is a practical and cost-effective method for recycling PET waste, such as breaking it down into monomers for depolymerisation or other chemicals that may be utilised for other applications. In this instance, we look at the biodegradation of waste PET as a viable approach for sustainably decreasing plastic pollution.

Objectives

In the current study, soil bacteria have been taken from an old PET bottle to test the bacteria's capacity to break down PET microplastics.

2. Materials And Methods

2.1. Bacterial isolation and identification

The old PET waste bottle was collected from the waste dumping site (St. Joseph University, Dimapur Nagaland, India). The waste bottle was cut into small pieces and washed properly with distilled water and let it to dry. It was then directly inoculated in Nutrient Agar. The media plate was incubated at 37˚C for 24 hours allowing for the bacterial growth. After 24 hours of incubation the bacterial were isolated and cultured separately using slant culture method. One bacteria were isolated and one has been selected for further study and 16s rRNA sequences were analyzed.

2.2. PET MPs sample preparation

PET plastic bottle was purchased and cut in small flakes and crash it to make microplastics after that it exposed UV light (Laminar Airflow chamber UV light) UV-PETMPs for 15 days Untreated on used as control. Pre-treated (UV-PETMP) and control PET powder (without pre-treated (UT-PETMP) sample inoculate with *Microbacterim hydrocarbonxydans* in the Minimal salt media (MSM: Minimal Salts media was prepared by dissolving 1.73g K_2HPO_4, 0.1g $MgSO_4.2H_2O$, 4g NaCl, 0.03 $FeSO_4.7H_2O$, 1g KNO_3, 0.02g CaCl2.H_2O in 1000ml of distilled water). The whole culture media was incubated for a period of six month at a temperature of 37˚C. End the experiment the supernatant of MSM were subjected by GCMS.

2.3. FTIR analysis

End the experiment the microplastics (UT-PETMP and UV-PETMP) were subjected by FTIR. Chemical changes occurring on the surface of the PET were analysed using FTIR spectrophotometer Fourier transform infrared (FTIR). Measurements were carried out with the Perkin Elmer Spectrum two (version 10.03.09) in the range of 4000-400 cm^{-1}. FTIR spectra were recorded at a resolution of 2cm^{-1} and at an accumulation of 32 scans.

2.4. Gas Chromatography-Mass Spectroscopy Method

The MSM medium supernatant was centrifuged and GC-MS analysis was performed on both UV-treated and untreated PET microplastics after a 6-month incubation period. GC-MS analysis was carried out using GC-MS (QP2010 PLUS Shimadzu, Japan). The column oven temperature was 60.0˚C and injection temperature was 260˚C. A pressure of 73.3 kPa was maintained with a total flow of 16.3 mL/min and a column flow of 1.21 mL/min. The linear velocity was 40.1 cm/sec, purge flow of 3.0 mL /min and a split ratio of 10.0. The GC program ion source temperature was 230.00˚C, interface temperature 270.00˚C with a solvent cut time of 3.50 min. The MS program start time was 4.00 min and ended at 44.00 min. the event time was 0.20 sec at a scan speed of 1666µl/sec. Mass spectra were recorded and the range was m/z 30-500

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amu. The total running time was 40 minutes. Identification of components**:** The National Institute of Standard and Technology's (NIST) database and WILEY 8 were used to interpret the mass spectrum of the GC-MS. The name, structure and molecular weight of the components present were ascertained. The percentage of the each compound present was calculated by comparing the individual peak area to the total area.

3. Results

To examine the impact of PET microplastics degradation using GC-MS in MSM media including bacteria and UV-treated microplastics (UVPETMP), as well as in the absence of pre-treated microplastics (UT-PETMP) containing medium. The following components were identified in MSM medium after six months incubation of PET microplastics. 13-Docosenoic acid, methyl ester (12.81%), GLucidyl (Z)-9 nonadecenoate (8.43%),2,3-Dihydroxypropyl cis-13-docosenoate (8.05%),1,1- Dichloro -2, 2, 3,3-Tetramethylcyclopropan (5.77%), 1-Cyclohexyldimethylsilyoxybutane (5%), 3- Dodecen-1 Al (4.95 %), 13- Docosenamide (4.48 %), 3-pentylpiperidin-2-one (4.12 %), (Z)-9octadecen-4-olide (3.47%) , Diethyl phthalate (3.20 %), 9-Octadecenoic acid (Z)-, methylester (2.71 %), Hexadecanoic acid , methyl ester (2.58 %), Tridecanedial (2.43 %), 9-Octadecenoic acid (Z)-,oxiranymethyl ester (2.25 %), stigmast-5 EN-3 OL, Oleat (2.16 %), Methyl 9-(Acetyloxy)-3,6B,10,10,12 A,12B,14A-HE (2.02 %), Methyl stearate (1.81 %) URS-12EN-28 AL (1.7%), 9,12,-Octadecadienoic acid (Z,Z)-,methyl ester (1.58 %), 3-pentylpiperidin -2-one (1.28 %) (Z)- 18- Octadec-9enolide (1.27 %), Hesadecanamide (1.26 %), Dodecanamide (1.25 %) ,9-Octadecenoic acid (Z)-, oxiranylmethyl ester (1.15%), Ergosta-4,6,22-triene (1.09 %), Dibutyl phthalate (0.96 %), 2,5-pyrrolidinedione, 3- dodecyle (0.94%), 9-Octadecenoic acid (Z)-, 2, 3-dihydroxypropyl ester, 2,5-pyrrolidinedione,3-dodecyl (0.92%), 15- Tetracosenoic acid, methyl ester (0.8 %),9- Octadecenamide (0.75%) cis-13- Eicosenoic acid, methyl ester (0.69 %), 25-Hydroxycholesterol, 2TMs derivative (0.67 %), 2(1H)-Azocinone, hexahydro (0.62 %), cis-9-Hexadecenal (0.61%), Octadecanoic acid,9,10 dihyroxy,methyl (0.54%), cis-13-Eicosenoic acid, methyl ester (0.45%),1-Nonadecene (0.44%), Bis(2-ethylhexyl)phthalate (0.43 %), cis-1,2-cyclododecanediol (0.35 %). Decane, 2,3,7-trimethyl (0.30 %), Oxalic acid,6-ethyloct-3yl ethyl ester (0.25 %), Methyl(3-Oxo-2-Pentylcyclopentyl) acetate (0.22 %), Decanedioic acid, didecyl ester (0.22 %), 1-(4-isopropylphenyl)-2-methylpropyl acetat (0.21%), 8-Methylnonamoic acid, methyl ester (0.18 %) (Fig-1, Table-1).

To examine the impact of PET microplastics degradation using GC-MS in MSM media including bacteria and without pre-treated microplastics (UT-PETMP) containing medium. (Fig-2,Table-2). 13-Docosenoic acid, methyl ester, (Z) (20.3%), Glycidyl (Z)-9-nonadecenoate (10.51%),2,3- Dihydroxypropylcis -13-docosenoate (10.45%), 1-Cyclohexyldimethylsilyloxybutane (7.83 %), 9-OCTADECENOIC ACID (Z)-, METHYL ESTER (3.94 %), cis-methyl 11- eicosenoate (3.58%), 13-Docosenamide (2.97%), Hexadecanoic acid methyl ester (2.79 %), METHYL 9-(ACETYLOXY)-3,6B,10,10,12A,12B,14A-HE (2.65 %), 9-Octadecenoic acid (Z)-, oxiranylmethyl ester (2.16 %),9,12- Octadecadienoic acid(Z,Z)-,methyl ester (2.03 %), STIGMAST-5-EN-3-OL, OLEAT (1.96 %), Methyl stearate (1.81%), 2-PROPENYL IONONE 3(1.59 %),Tricyclo[20.8.0.0e7,16]Triacontan, 1(22),7(16)-Di (1.71%), 1,2-Benzenedicarboxylic Acid, Diethyl Ester (1.53 %), Phenol,2,4-bis (1,1-dimethylethyl) phosphate (1.45%), 9-Octadecenoic acid (Z)-, oxiranylmethyl ester (1.38 %), 9-Octadecenoic acid (Z)-, 2,3-dihydroxypropyl ester (1.12%), (Z)-9-octadecen-4-olide (1.08%), Dibutyl phthalate (0.95 %), Campesterol (0.93 %), cis-9-Hexadecenal (0.85 %), 9-Octadecen-1-ol (0.83%), 4-PHENYLDECAN-4-OL (0.72 %),DOCOSANOIC ACID, METHYL ESTER (0.69%), Bis(2-ethylhexyl) phthalate (0.66%), (2E,4E)-N-Isobutylhexadeca-2,4-dienamide (0.62 %), Oxiraneoctanoic acid,3-octyl-methyl ester (0.59 %), Formic acid, dec-2-yl ester (0.52 %), Methyl 9,10- Dideutero-9-Octadecenoate (0.47 %), Hexadecanoic acid,1-[[[(2- aminoethoxy phosphimyl (0.41 %), N,N'-Bis(Trifluoroacetyl)-N,N'-Ethylene-Bis(S) (0.3 %), (E)-Hexadec-2-Enal (0.29 %), Cyclohexanepropanol, .Alpha.-Methyl (0.24 %), 16-Deoxokryptogenin (0.19 %), Heptane (0.18 %), 7.beta.,11.alpha.-Dihydroxydiosgenin (0.13 %).

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FTIR spectra of Control PET micro plastic performed form 200 cm^{-1} to 400 cm^{-1} wave number region. The absorption band at 3800 cm^{-1}, 3852 cm^{-1}, 3739 cm^{-1} and 3435 cm^{-1} has been attributed to O-H bond stretching. The absorption band at 2925 cm^{-1}, 2856 cm^{-1},1450 cm^{-1} , 1384 cm^{-1}, 871 cm^{-1} and 832 cm^{-1} has been attributed to C-H bond stretching. The absorption band at 2426 cm^{-1}, 2370 cm^{-1}, 2340 cm^{-1}, 2081 cm^{-1}, 2027 cm^{-1} has been attributed to C=O bond stretching. The absorption band at 1638 cm^{-1} has been attributed to C-C bond stretching, 1270 cm^{-1} ((C=O)-O bond stretching), 1092 cm^{-1}, 1035 cm^{-1} has been O-C-C bond stretching (Fig-3,Table-3).

FTIR spectra of *M.hydrocarbonxydans* bacterial treated without pre-treated microplastics were performed from 200 cm^{-1} to 400 cm^{-1} after six month incubation in MSM. The absorption band at 3431 cm^{-1} has been attributed to O-H bond stretching, The characteristic vibration band observed at 2963 cm^{-1}, 2925 cm^{-1}, 1021 cm^{-1}, 873 cm^{-1}, 839 cm^{-1},779 and 722 cm^{-1} has been C-H bond stretching, 2427 cm^{-1} and 2026 cm^{-1} has been attribute to C=O bond stretching, 1637 cm^{-1} has been C-C bond stretching, 1270 cm^{-1} ((C=O)-O bond stretching),1099 cm^{-1} (O-C-C bond stretching). On inoculation of without Pre-treated PET microplastics with *M .hydrocarbonxydans*, appearance of new peaks at 2963 cm^{-1}, 779 cm^{-1} and 722 cm^{-1} was evidence in the FTIR spectra which has been attributed C-H bond stretching. The FTIR spectra presented in Figure (Fig-4,Fig-5) show that peak appearances at 3434 cm^{-1} (O-H bond stretching), 2026 cm^{-1} (C=O bond stretching), 1631 cm^{-1} (C-C bond stretching), 1384 cm^{-1} (C-H bond stretching), 1271 cm^{-1} (C=O)-O bond stretching), 1018 cm^{-1} (C-H bond stretching), 871 cm^{-1} (C-H bond stretching), 764 cm^{-1}, and 710 cm^{-1} (C-H bond stretching) were observed after inoculation of UV-exposed PET microplastics with *M. hydrocarbonxydans* in MSM. Following the inoculation of PET microplastics subjected to UV light, additional peaks were seen at 1437 cm^{-1}, 1406 cm^{-1}, 1349 cm^{-1}, 1319 cm^{-1}, and 953 cm^{-1}. These peaks have been assigned to C-H bond stretching and the peaks 1121 has been attributed C=O bond stretching. When comparing the pretreatment PET microplastics and without pre-treatments microplastics to the control PET microplastics, a significant amount of peaks were found. The 16s rRNA sequences were obtained and similarity analysis by BLAST. It is 99.9 % identical similarity with the voucher sequences of NCBI (Fig-6).

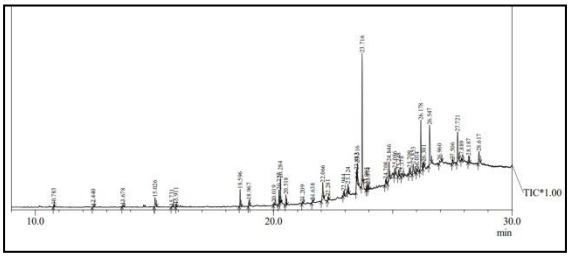

Fig-1: GCMS of UT-PETMP containing MSM

S.NO	R.Time	Area	Area%	Name
1	10.783	28582	0.35	DOCOSANE
2	12.440	7829	0.10	CYCLOHEXANE,1,1,3-TRIMETHYL-2-PROPYL-,TRA
3	13.678	27843	0.34	Decane,3,3,8-trimethyl-
4	15.026	182258	2.23	1,2-BENZENEDICARBOXYLICAC ID,DIETHYLESTER
5	15.731	14776	0.18	BIS(CYCLOPENTYLMETHYL)ETHER
6	15.911	31765	0.39	1-(4-ISOPROPYLPHENYL)-2-METHYLPROPYLACETA
7	18.596	235173	2.88	Hexadecanoicacid,methyl ester
8	18.967	79866	0.98	1,2-BENZENEDICARBOXYLICA CID,DIBUTYLESTE
9	20.019	49247	0.60	Formicacid,undecylester
10	20.227	171553	2.10	9,12-Octadecadienoicacid(Z,Z)-,methylester
11	20.284	331309	4.05	9-OCTADECENOICACID(Z)-,METHYLESTER
12	20.518	137048	1.68	Methylstearate
13	21.209	30282	0.37	2-Dodecenal,(E)-
14	21.638	31167	0.38	Hexadecanoicacid,1-[[[(2-aminoethoxy)hydroxyphosphinyl
15	22.066	320929	3.93	cis-Methyl11-eicosenoate

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16	22.281	55565	0.68	OCTADECANOICACID,METHYLESTER
17	22.944	84744	1.04	cis-9-Hexadecenal
18	23.124	101984	1.25	9-Octadecenoicacid(Z)-,2,3-dihydroxypropylester
19	23.482	137662	1.68	Methyl(Z)-5,11,14,17-eicosatetraenoate
20	23.516	177779	2.18	9-Octadecenoicacid(Z)-,oxiranylmethylester
21	23.716	1760513	21.54	13-Docosenoicacid,methylester,(Z)-
22	23.905	61055	0.75	DOCOSANOICACID,METHYLESTER
23	23.974	70763	0.87	1,2-BENZENEDICARBOXYLICACID
24	24.708	82727	1.01	(Z)-(Z)-icos-11-en-1-ylicos-11-enoate
25	24.846	406140	4.97	1-Cyclohexyldimethylsilyloxybutane
26	25.086	106481	1.30	Glycidyl(Z)-9-nonadecenoate
27	25.248	91740	1.12	15-Tetracosenoicacid,methylester,(Z)-
28	25.378	102899	1.26	10,13-OCTADECADIENOICACID,METHYLESTER
29	25.709	130549	1.60	3-Acetoxy-12-ursanol
30	25.853	237281	2.90	13-Docosenamide,(Z)-
31	26.014	37779	0.46	HEXADECANAL
32	26.178	881702	10.79	2,3-Dihydroxypropylcis-13-docosenoate
33	26.301	80678	0.99	DECANE,1-(3-METHYL-1-INDANYL)-
34	26.547	857193	10.49	Glycidyl(Z)-9-nonadecenoate
35	26.960	56351	0.69	Z-8-Tetradecen-1-ylacetate
36	27.506	35636	0.44	3.beta.-Acetoxy-5-cholenicacid
37	27.721	551406	6.75	1-Cyclohexyldimethylsilyloxybutane
38	27.889	27937	0.34	17.alpha.-Hydroxypregnenolone
39	28.187	129477	1.58	Stigmasta-3,5-diene
40	28.617	226629	2.77	Silane,dimethyl(dimethyl(but-3-enyloxy)silyloxy)isobutoxy-
		8172297	100.00	

Table-1: Profile of biodegraded compounds in UT-PETMP containing MSM

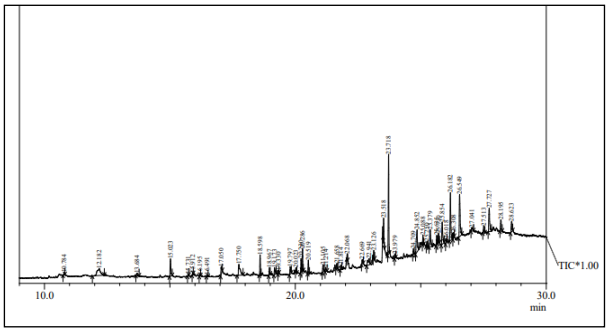

Fig -2 : GCMS of UVPETMP containing MSM

Peak	R.Time	Area	Area %	Name
1	10.784	29889	0.30	DECANE, 2,3,7-TRIMETHYL-
2	12.182	499080	4.95	3-DODECEN-1-AL
3	13.684	25288	0.25	Oxalic acid, 6-ethyloct-3-yl ethyl ester
4	15.023	322855	3.20	Diethyl Phthalate
5	15.731	21961	0.22	METHYL (3-OXO-2-PENTYLCYCLOPENTYL)ACETATE
6	15.912	21065	0.21	1-(4-ISOPROPYLPHENYL)-2 METHYLPROPYL ACETAT
7	16.195	22055	0.22	DECANEDIOIC ACID, DIDECYL ESTER
8	16.49	18567	0.18	8-Methylnonanoic acid,

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	1			methyl ester
9	17.050	125609	1.25	Dodecanamide
10	17.750	415442	4.12	3-pentylpiperidin-2-one
11	18.598	260049	2.58	Hexadecanoic acid, methyl ester
12	18.967	97184	0.96	Dibutyl phthalate
13	19.173	137382	1.36	Hexadecanamide
14	19.330	35292	0.35	cis-1,2-Cyclododecanediol
15	19.797	129523	1.28	3-pentylpiperidin-2-one
16	20.023	44745	0.44	1-Nonadecene
17	20.230	159450	1.58	9,12-Octadecadienoic acid (Z,Z)-, methyl ester
18	20.286	273784	2.71	9-OCTADECENOIC ACID (Z)-, METHYL ESTER
19	20.519	182275	1.81	Methyl stearate
20	21.105	126827	1.26	Hexadecanamide
21	21.214	61788	0.61	cis-9-Hexadecenal
22	21.658	95227	0.94	2,5-pyrrolidinedione, 3-dodecyl-
23	21.814	62746	0.62	2(1H)-AZOCINONE, HEXAHYDRO-
24	22.068	45810	0.45	cis-13-Eicosenoic acid, methyl ester
25	22.669	75183	0.75	9-OCTADECENAMIDE
26	22.941	245017	2.43	Tridecanedial
27	23.126	92873	0.92	9-Octadecenoic acid (Z)-, 2,3-dihydroxypropyl ester
28	23.518	226870	2.25	9-Octadecenoic acid (Z)-, oxiranylmethyl ester
29	23.718	1292227	12.81	13-Docosenoic acid, methyl ester, (Z)-
30	23.979	43631	0.43	Bis(2-ethylhexyl) phthalate
31	24.70	69626	0.69	cis-13-Eicosenoic acid,
	9			methyl ester
32	24.852	581704	5.77	1,1-DICHLORO-2,2,3,3-TETRAMETHYLCYCLOPRO PAN
33	25.088	116409	1.15	9-Octadecenoic acid (Z)-, oxiranylmethyl ester
34	25.250	81115	0.80	15-Tetracosenoic acid, methyl ester, (Z)-
35	25.379	350010	3.47	(Z)-9-octadecen-4-olide
36	25.635	128249	1.27	(Z)-18-Octadec-9-enolide
37	25.710	171237	1.70	URS-12-EN-28-AL
38	25.854	451829	4.48	13-Docosenamide, (Z)-
39	26.018	54891	0.54	OCTADECANOIC ACID, 9,10-DIHYDROXY-, METHYL
40	26.182	811434	8.05	2,3-Dihydroxypropyl cis-13-docosenoate
41	26.308	67590	0.67	25-Hydroxycholesterol, 2TMS derivative
42	26.549	850135	8.43	Glycidyl (Z)-9-nonadecenoate
43	27.041	109904	1.09	Ergosta-4,6,22-triene
44	27.513	125576	1.25	(3S,8S,9S,10R,13R,14S,17R)-17-((2R,5R)-5,6-Dimethylhep
45	27.727	504695	5.00	1-Cyclohexyldimethylsilyloxybutane
46	28.195	217969	2.16	STIGMAST-5-EN-3-OL, OLEAT
47	28.623	203327	2.02	METHYL 9-(ACETYLOXY)-3,6B,10,10,12A,12B,14A-HE
		10085394	100.00	

Table- 2 : Profile of Biodegraded compounds in UVPETMP containing MSM

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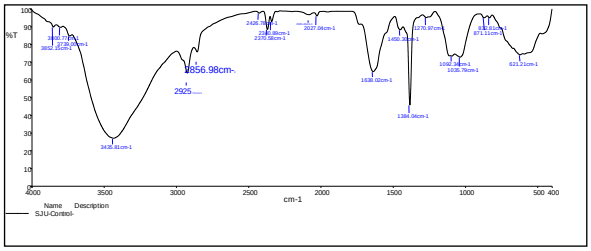

Fig -3: FTIR spectrum of Control PET Microplastics

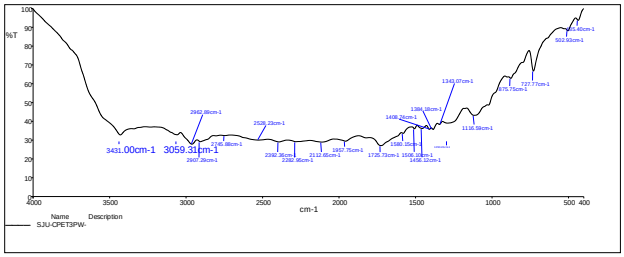

Fig -4: FTIR spectrum of *Microbacterium hydrocarbonoxydans inoculated* UT-PETMP

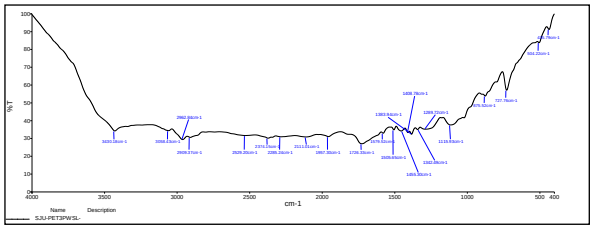

Fig -5: FTIR spectrum of *Microbacterium hydrocarbonoxydans* treated UVPETMP

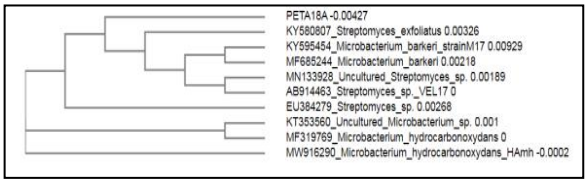

Fig -6: Phylogenetic tree of *M. hydrocarbonoxydans*

Control PET powder	Functional group	*M.hydrocarbonoxydans* + PET powder	Functional group
3800.77	O-H	3431.77	O-H
3852.15	O-H	2963.27	C-H
3739.00	O-H	2925.46	C-H
3435.81	O-H	2427.69	C=O
2925.71	C-H	2026.85	C=O
2856.98	C-H	1637.42	C-C
		1384.01	C-H
2426.78	C=O	1270.98	(C=O)-O
2370.58	C=O	1099.70	O-C-C
2340.89	C=O	1021.01	C-H
2081.46	C=O	873.77	C-H
2027.04	C=O	839.90	C-H
1638.02	C-C	779.78	C-H
1450.30	C-H	722.43	C-H
1384.04	C-H		
1270.97	(C=O)-O		
1092.34	O-C-C		
1035.79	C-H		
871.11	C-H		
832.81	C-H		

Table -3: Band Assignment of FTIR of PET microplastics

Control PET powder	Functional group	UV light +*M.hydrocarbonoxydans* + PET powder	Functional group
3800.77	O-H	3434.35	O-H
3852.15	O-H	2026.04	C=O
3739.00	O-H	1631.58	C-C
3435.81	O-H	1437.09	C-H
2925.71	C-H	1406.41	C-H
2856.98	C-H	1384.44	C-H
		1349.42	C-H
2426.78	C=O	1319.46	C-H
2370.58	C=O	1271.26	(C=O)-O
2340.89	C=O	1121.63	C=O
2081.46	C=O	1018.71	C-H
2027.04	C=O	953.34	C-H
1638.02	C-C	871.40	C-H
1450.30	C-H	764.80	C-H
1384.04	C-H	710.23	C-H
1270.97	(C=O)-O		
1092.34	O-C-C		
1035.79	C-H		
871.11	C-H		
832.81	C-H		

Table -3a: Band Assignment of FTIR of PET microplastics

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4. Discussion

FTIR spectra of PET microplastics have been displayed in Fig-1. PET constitutes molecular groups like C, H and O, which are highly infrared active and have characteristic absorption peaks. The O-H stretching modes of vibrations are weak band, involve O and H atoms, and show up at higher wave numbers in different functional groups. The O-H stretching mode in alknol (OH) alkyl groups (CH3, CH2 and CH) exist in the inferred absorption spectra in the region 3650- 3590 cm^{1}. These refer to functional group such as alcohol, which appear as absorption peaks in the region 3783 cm^{-1} to 3430 cm^{-1} [13] (Shiv Govind Prasad et al., 2011). The characteristic vibration band observed at 3434 cm^{-1}, 3800 cm^{-1}, 3852 cm^{-1} and 2963 cm^{-1}, 2925 cm^{-1} has been assigned to C-H stretching (aromatic and methyl groups, respectively).

In comparison to the FTIR spectra of control PET, without pre-treated PET microplastics and UV exposed PET microplastics treated in the MSM medium with bacteria, indicated chemical changes through the new peaks appearances. The findings of Navid Taghavi et al. (2021) make parallel with this result, as they reported that chemical transformation in UV-treated and bio-treated materials revealed new peaks, suggesting that UV has a beneficial effect on biodegradation efficiency[14]. In the study, The hydrocarbon family's various carboxylic acids were found in the biodegraded samples (UV light-exposed PET microplastics and untreated PET microplastics) by GC MS analysis; nevertheless, the results showed no discernible difference between the two groups of microplastics. However, when the microplastics were subjected to UV light, diethyl phthalates, dibutyl phthalates, bis(2-ethylhexyl) phthalates and 3-Dodecen-1 AL were found in the MSM media. This result parallel with the study of Chiara Gnoffo and Alberto Frache, (2024) they were identified microplastics by GCMS methods from multicomponents of plastic mixture. In the present study bis(2-ethylhexyl) phthalates were identified in UV treated PET microplastics containing MSM medium similarity result find in the previous reports of Laxmi Kant Bhardwaj and Archana Sharma (2021) they were identified Bis (2-ethylhexyl) phthalate (DEHP) in drinking water bottles by GCMS.

Conclusion

In this study, the authors used GC-MS and FTIR to identify broken-down plastic components in pre-treated microplastics and bacterially infected media. The resistance barrier structure of its bioprocessing is broken and the efficiency of biodegradation is increased when biological and physical treatments are combined. It is anticipated that this combination processing method, which is more industrialized and applied will be utilized to deal with the microplastics contamination problem.

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