College of Natural and Health Science (CNHS)

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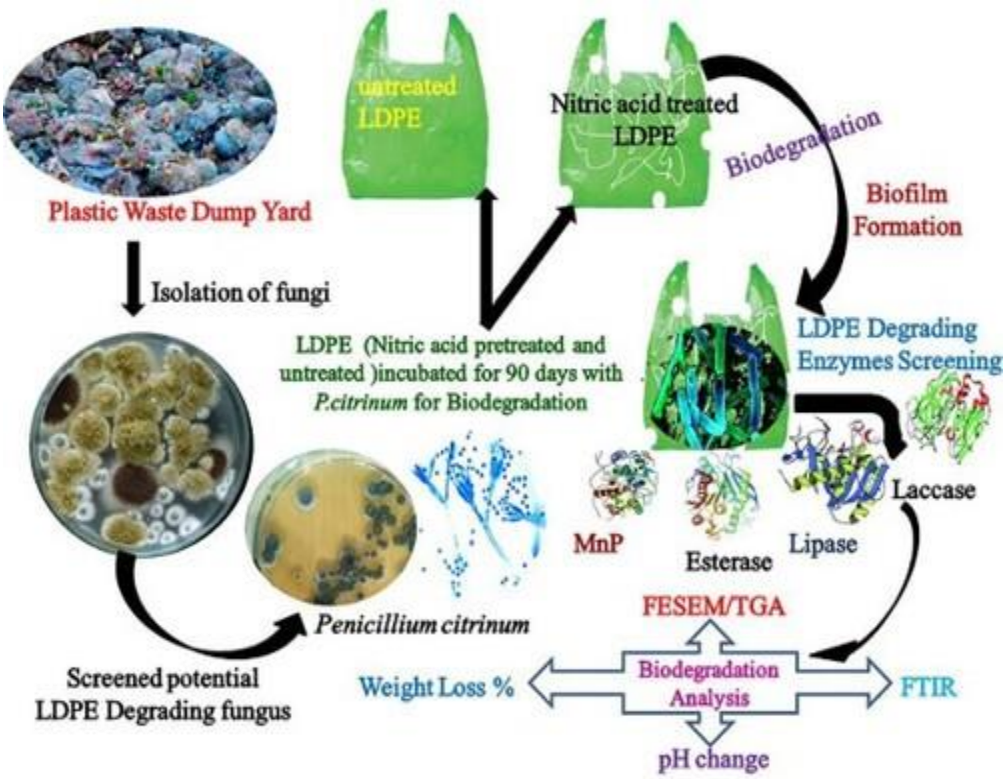
Degradation of Pharmaceutical waste by Fungi



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Sr. No	Author	Tittle	Year	Journal	Study design and Settings	Sample size	Main findings
1	D. Trivedi, Deepak W Deshka, J V Narute, V. D. Somvanshi	Degradation of biomedical waste including plastic waste by fungus periconiella species	2019	Indian Journal of Microbiology Research			Within 40 days, it is found that Periconiella sp. f degrades biomedical waste mass better than other fungi. , it is a cost-effective, low-maintenance, and environmentally sustainable method of disposing of biomedical waste, including plastic waste.
2	S. Pradeep, Sailas Benjamin	Mycelial fungi completely remediate di(2-ethylhexyl) phthalate, the hazardous plasticizer in PVC blood storage bags.	2012	Journal of Hazardous Materials			In basal salt medium (BSM) the growth of A. Parasiticus and F.subglutinas showed good growth on PVC pipes, F.subglutinas was efficient in completely utilizing the di(2-ethylhexyl) phthalate (DEHP) within blood storage bags that shows inexpensive ecofriendly bioremediation phthalate in pharmaceutical waste.
3	Bayda A. Yahya	The Use of the Fungi Penicillium and Rhizopus to Remove Some	2021	Annals of the Roamani an society			Penicillium and Rhizopus are effective in removing toxic heavy

		Heavy Metals from the Wastewater in Hospital in Mosul Cit		for cell biology			metals from pharmaceutical waste. It was found that penicillium was better at settling Pb and Cd than Rhizopus (53.75% and 72.73%, respectively, on the tenth day of incubation
4	Satarupa Dey, Uttpal Anand, Vineet Kumar, Sunil Kumar, Mimosa Ghorai, Arabinda Ghosh, Nishi Kant, S. Suresh, Sayan Bhattacharya, Elza Bontempi, Sartaj Ahmad Bhat, Abhijit Dey	Microbial strategies for degradation of microplastics generated from COVID-19 healthcare waste	2023	Environmental research			By degrading the microplastics (MPs) by axenic and mixed culture microorganisms, including bacteria, fungus, and microalgae that can be regarded as an environmentally viable method for reducing the threat of microplastics. The incineration of this waste releases furans, dioxin, microplastic, and toxic metals such as cadmium and lead
5	Yanju Li, Haibo Chen , Yuzhou Wang , Zhengli Yang , Huiyan Zhang	Efficient biodegradation of chlortetracycline in high concentration from strong-	2022	Journal of Hazardous Materials			Self screened fungi (LJ302) lowered CRR toxicity from 96.02% to no effect on Micrococcus luteus.

		acidity pharmaceutical residue with degrading fungi					Fungi strains may biodegrade CTC, high acidity, and biotoxicity of CRR together.
6	Nikita Dhiman , Savita Chaudhary , Avtar Singh , Archana Chauhan , Rajeev Kumar	Sustainable degradation of pharmaceutical waste using different fungal strains: Enzyme induction, kinetics and isotherm studies	2022	Environmental Technology & Innovation			Triticum aestivum, P. aeruginosa, and S. aureus toxicity testing show the test fungal strains exhibit extraordinary detoxifying capacity. Diclofenac sodium (DCF) biodegradation into intermediates was found and explained using FTIR, LCMS, SEM, and EDS. DCF adsorption onto fungal biomass was studied using systematic isotherm and kinetic investigations.
7	Keiko Yamada-Onodera, Hiroshi Mukumoto , Yuhji Katsuyaya , Atsushi Saiganji ,	Degradation of polyethylene by a fungus, Penicillium simplicissimum YK	2001				Polyethylene bioremediation may become possible with the help of Penicillium simplicissimum.

	Yoshiki Tani						The pure fungal growth phase causes the breakdown of polyethylene. Biodegradable polyethylene had functional groups.
8	Shazia Khan,Sharique A. Ali &Ayesha S. Ali	Biodegradation of low density polyethylene (LDPE) by mesophilic fungus 'Penicillium citrinum' isolated from soils of plastic waste dump yard, Bhopal, India	2022				Penicillium citrinum degrade *low density polyethylene* LDPE without pretreatment. P.citrinum demonstrated 38.82 ± 1.08% weight loss for untreated LDPE pieces. Nitric acid pretreatment resulted in a 47.22 ± 2.04% increase in biodegradation.
9	Sowmya, H.V. ,Ramalingappa , B. , Nayanashree, G. Thippeswamy, B. Krishnappa, M.	Polyethylene Degradation by Fungal Consortium	2014	Int. J. Environ. Res.,			fungi consortiums play role in polyethylene breakdown over single microorganisms in an eco-friendly manner without any negative impacts. The weight loss of Curvularia lunata (1.2%), Alternaria alternata (0.8%), Penicillium simplicissimum (7.7%), and Fusarium sp. (0.7%) was lower than their combined weight loss of 27%.
10	Iryna Rusyn, Olena V. Dmytruk, , Kostyantyn V.	Filamentous fungi for sustainable remediation of	2023				filamentous fungi are ideal for bioremediation of developing

	Dmytruk, , Helen Onyeaka, Marieka Gryzenhout, and Yusufjon Gafforov ,	pharmaceutical compounds, heavy metal and oil hydrocarbons					pharmaceutical pollutants due to their efficiency and speed in eliminating a wide range of pollutant chemicals. Filamentous fungi use bio-adsorption, bio-surfactant synthesis, bio-mineralization, bio-precipitation, and extracellular and intracellular enzymatic activities for bioremediation.

Literature Review

Introduction:

According to Deshkar et al.2019 the biomedical waste mass includes soiled cotton, gauze pieces, dressing material, surgically removed pieces, and plastic waste. Polyethylene is a synthetic polymer used in the formation of the medical industry. Increased use of polyethylene causes severe environmental problems (H.V.Sowmya et al.2014). DEHP-containing PVC scraps, bags, used PVC medical equipment, etc., are frequently buried or thrown in the ground. The DEHP will seep into the soil during this process, eventually making its way into the human body (Pradeep et al.,2012). My curiosity encouraged me to know more about the fungi that cause the degradation of pharmaceutical waste because studying various fungi could save the environment and public health.

The article by Deshkar et al. (2019) aimed to find the degradation of biomedical waste containing soiled cotton, gauze pieces, dressing material, surgically removed tissue pieces, and plastic using the fungus Periconiella. In this study, Indian Deshi cow dung incubated at room temperature was used to cultivate the coprophilous fungus Periconiella sp. on culture plates. It was discovered that the grown fungus Periconiella sp. was both saprophytic and coprophilic.

In a period of 18 to 40 days, the cultured fungus from every culture plate could break down 25g of biomedical waste, which included soiled cotton, gauze fragments, dressing material, surgically removed tissue parts, and plastic trash. The Authors of this study conclude that Within 40 days, it is found that Periconiella sp. f degrades biomedical waste mass better than other fungi. Furthermore, it is a cost-effective, low-maintenance, and environmentally sustainable method of disposing of biomedical waste, including plastic waste.

The article by Pradeep et al. (2012) aimed to investigate how the novel fungi degrade the alarming plasticizer, di(2-ethylhexyl) phthalate (DEHP) that is in the PVC blood storage bags (BB). The DEHP is a highly carcinogen for human beings. In this study the three groups of mycelial fungi, viz., Aspergillus parasiticus, Fusarium subglutinans and Penicillium funiculosum and blood storage bags containing DEHP (33.5% w/w) were collected. The total DEHP in the BB was extracted with the help of n-hexane. For complete removal of DEHP from the BB a two-stage cultivation strategy was adopted. 70% DEHP present in BB was consumed in the 2 weeks during the first growth stage. In the second phase, the DEHP in BB was completely (99%) removed. In basal salt medium (BSM) the growth of A. Parasiticus and F.subglutinas showed good growth on PVC pipes. The researcher in this study believes that F.subglutinas was efficient in completely utilizing the DEHP within BB that shows inexpensive ecofriendly bioremediation phthalate in pharmaceutical waste.

The article by Yahya et al. (2021) aimed to detoxify some heavy metals from the wastewater of Mosul Hospital by using the fungi penicillium and Rhizopus. In this study, the fungi penicillium and Rhizopus were taken to remove toxic elements like lead, cadmium, and copper from pharmaceutical wastewater. Atomic observation devices were used to determine the concentration of Pb, Cd, and Cu elements before and after the fungi cultivation process. An incubation period of 0,3,5,7,10 days was selected to compare the precipitation concentration of each element. It was found that penicillium was better at settling Pb and Cd than Rhizopus (53.75% and 72.73%, respectively, on the tenth day of incubation). In contrast, the Rhizopus fungus had a copper precipitation rate of 87.18% on the tenth day, higher than the penicillium rate of 73.07% for the same time frame. The author concluded that Penicillium and Rhizopus are effective in removing toxic heavy metals from pharmaceutical waste.

The article by Dey et al. (2023) aimed to explain the degradation of microplastic (MPs) by cultured microorganisms such as fungi. In this study mixed culture microorganisms such as fungi, bacteria, and microalgae were taken. The COVID-19 epidemic has generated huge plastic waste from gloves, masks, tissues, and other Equipment. Single-use disposable masks of polyethylene, polyurethane, polyacrylonitrile, polypropylene, and polystyrene can harm environmental, human, and animal health. The incineration of this waste releases furans, dioxin, microplastic, and toxic metals such as cadmium and lead. The author advises that we should degrade the microplastics (MPs) by axenic and mixed culture microorganisms, including bacteria, fungus, and microalgae that can be regarded as an environmentally viable method for reducing the threat of microplastics.

The article by Li et al. (2022) aimed to find the degradation of Chlortetracycline (CTC) pharmaceutical residue with the help of fungi. In this study, three self-screened fungi, LJ245, LJ302, and LJ318, were used to remove CTC, and biotoxicity in raw residue. The data showed that CTC concentration reduced rapidly in the first seven days. The degradation ratios of the three strains were 95.73%, 98.53%, and 98.07%. The strong acidity of CRR declined as the pH value increased from 2.30 to 8.32. LJ302 lowered CRR toxicity from 96.02% to no effect on Micrococcus luteus. Thus, the author proposed that strains may biodegrade CTC, high acidity, and biotoxicity of CRR together.

The article by Dhiman et al. (2022) aimed to find out that fungal biomass can significantly reduce the toxicological impacts of pharmaceutical waste on the environment. In this study, two wood-rotting fungi, Bjerkandera adusta and Fomitopsis meliae, degraded diclofenac up to 93%, 91%, and 90%. The degradation behavior near pH, biomass, concentration, and temperature was examined. Diclofenac sodium (DCF) biodegradation into intermediates was found and explained using FTIR, LCMS, SEM, and EDS. DCF adsorption onto fungal biomass was studied using systematic isotherm and kinetic investigations. The author concluded that Additionally, Triticum aestivum, P. aeruginosa, and S. aureus toxicity testing show the test fungal strains exhibit extraordinary detoxifying capacity.

The article by Onodera et al. (2001) aimed to find how the strain of fungi degrades pharmaceutical waste like polyethylene. In this study, *Penicillium simplicissimum was isolated for the biodegradation of polyethylene.* Polyethylene with beginning molecular weights of 4000 to 28,000 had reduced molecular weights after 3 months of liquid incubation with fungus hyphae. UV irradiation or nitric acid incubation at 80°C for 6 days before cultivation introduced functional groups into polyethylene. The pure fungal growth phase causes the breakdown of polyethylene. Biodegradable polyethylene had functional groups. They concluded that

Polyethylene bioremediation may become possible with the help of Penicillium simplicissimum.

The article by Khan et al. (2022) aimed to check the ability of *Penicillium citrinum for biodegradtion of low-density polyethylene (LPDE). In this study* they extract strong PE-degrading fungus from Bhopal's plastic-laden municipal landfill soil. 16 fungal isolates from the site and PE degrading fungus was tested on mineral salt agar with 3% LDPE powder as the main carbon source. They found out that P.citrinum demonstrated $38.82 \pm 1.08\%$ weight loss for untreated LDPE pieces. Nitric acid pretreatment resulted in a $47.22 \pm 2.04\%$ increase in biodegradation. Spectrophotometers measured laccase, lipase, esterase, and manganese peroxidase. Further differences in biodegradable sample thermal decomposition rates compared to control confirm biodegradation. The authors confirmed that it is the first instance of P.citrinum degrading LDPE without pretreatment.

The article by Sowmya et al. (2014) aimed to find the degradation of various plastic waste with the help of fungi.In this study they recovered Curvularia lunata, Alternaria alternata, Penicillium simplicissimum, and Fusarium sp. from local dumpsites in Shivamogga Dist. Fourier Transform Infrared Spectroscopy, and Scanning Electron Microscopy tests confirmed the degradation of surface sterilized polyethylene The weight loss of Curvularia lunata (1.2%), Alternaria alternata (0.8%), Penicillium simplicissimum (7.7%), and Fusarium sp. (0.7%) was lower than their combined weight loss of 27%. They concluded that this experiment confirms the importance of fungi consortiums in polyethylene breakdown over single microorganisms in an eco-friendly manner without any negative impacts.

The article by Gosh et al. (2023) aimed to focus on bioremediation of waste with the help of filamentous fungi. In this study filamentous fungi employed to remove pollutants, including widely studied Aspergillus, Penicillium, Fusarium, Verticillium, Phanerochaete, and other Basidiomycota and Zygomycota species They believe that Filamentous fungi use bio-adsorption, bio-surfactant synthesis, bio-mineralization, bio-precipitation, and extracellular and intracellular enzymatic activities for bioremediation. They conclude that filamentous fungi are ideal for bioremediation of developing pharmaceutical pollutants due to their efficiency and speed in eliminating a wide range of pollutant chemicals.

Research Variables:

Type:	Variables:
Independent (Quantitative)	The concentration of pharmaceutical waste
Dependent (Qualitative)	Different types of fungi are used for the degradation of medical waste.
Controlled (constant)	• The number of fungi tested. • The location of fungi. • The enzymes that are used for degradation. • Different equipment to check the degradation ability of fungi.

Research Objective:

-Main Research Objective:

To evaluate the fungi that are involved in the degradation of pharmaceutical waste.

-Specific Research Objectives:

1. To measure the ability of penicillium to degrade pharmaceutical waste.
2. To measure the ability of Rhizopus to degrade pharmaceutical waste.
3. To explore what types of fungi can degrade medical waste.
4. To identify whether the degradation of medical waste is environmentally friendly or cost-effective.
5. To determine which type of fungi has the greatest ability to degrade the fungi.

Research Questions:

-Main Research questions:

What are the fungi that are involved in the degradation of pharmaceutical waste?

-Specific Research questions:

1. What is the role of penicillium in degrading pharmaceutical waste?

2. What role does Rhizopus play in degrading pharmaceutical waste?
3. What types of fungi can degrade medical waste?
4. Is the degradation of medical wastes by fungi environmentally friendly or cost-effective?
5. which type of fungi has the greatest ability to degrade the fungi?

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