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ON THE PRESENCE, ISOLATION AND CHARACTERIZATION OF DIFFERENT FUNGAL STRAINS FROM MUNICIPAL LANDFILL SITE DUMPED WITH PLASTICS

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ABSTRACT

Plastic is a naturally recalcitrant polymer, once it enters the environment, it will remain there for several years. Accretion of plastic as wastes in the environment poses a serious problem and causes an ecological threat. Various strategies to reduce accumulation of plastic wastes have been initiated and implemented from a different aspect including from microbiological view point. The current report is on the fungal flora of 35 years old municipal landfill site polluted with plastic. The site was chosen to increase the probability of finding the plastic degrading fungi which can use plastic as sole carbon source. This is the first attempt of exploring the fungal flora of the site selected by us. Prospective fungi were isolated by logarithmic dilution method and pure cultures were obtained by standard microbial procedures. Ten soil samples were tested for the incidence of fungal strains from plastic contaminated soil. A total of 30 fungal strains were isolated and 16 fungi were characterized morphologically and microscopically using standard method of staining. It was found that all the isolated species belongs to phylum Ascomycota and genus *Aspergillus, Trichoderma, Penicillium, Cladosporium* and *Fusarium.* Among the isolated fungal species, highest frequency observed is of *Penicillium chrysogenum complex* (16.44%) and *Aspergillus flavus (15.06%),* while the lowest frequency was of *Trichoderma viridae, Penicillium citrinum and Aspergillus clavatus (1.37%). The* other fungi that is *A. niger, A. terreus, A. nidulans, A. fumigates, A. amstelodami, A. oryzae, Penicillium verucosum, Fusarium oxysporum, Cladosporium pseudo cladosporides, Cladosporium cladosporides* and *Cladosporium sphaerospermum* were found between the range of 2.73% to 6.85%. These species of fungi probably degrade multiple types of plastics through the formation of Biofilm on the surface of plastic polymers where symbiotic relationship exists of biodegradation as well as nutrient utilization of carbon. The majority of fungal species particularly *Aspergillus flavus*, *Penicillium chrysogenum complex*, *Cladosporium pseudo cladosporides* and *Aspergillus niger* isolated from the site penetrate into the plastic polymer leading to its rapid degradation. The present data reflect the high potential of these fungal species for rapid biodegradation of plastic which has commercial applications if exploited properly.

Keywords: Plastic, Pollution, Bioremediation, Fungi, Ascomycota

INTRODUCTION

Plastic pollution is the accretion of plastic products like plastic bottles, bags, micro beads in the earth's environment that adversely affect humans, wildlife and wildlife habitat **[1, 2]**. Plastic is inexpensive, light weight and durable with wide ranging applications resulting in its huge production by industries **[3]**. In 1950 the rate of plastic production globally was 2 million tonnes per year which has increased 200 fold times to 380 million tonnes per year in the last five years. It was found that the packaging industry uses the most plastic produced in the world that is 146 million tonnes plastic per year. In packaging sector it has very short "in-use" lifetime i.e. around 6 months or less and then it is discarded as waste, creating mountains of plastic on the earth. High income countries including Europe, North America, Australia, New Zealand, Japan and South Korea have very effective waste management infrastructure and systems, where discarded plastic waste is stored in secure, closed landfills, though they contribute to plastic pollution by littering, a less serious menace. In a lot of low-to-middle-income countries, improperly disposed plastic waste is huge, as in South Asia and Sub-Saharan Africa; 80-90% of plastic waste is inadequately disposed of, and therefore is at risk of polluting environment and aquatic ecosystem **[4]**. Due to improper disposal strategies and lack of proper incineration, the plastic is burned in open releasing persistent organic pollutants (POPs) like furans and dioxins causing immune disorders, hormonal disruption, cancers and lung diseases in humans **[5]**. The toxic chemicals like Bisphenol A and phthalates that are included in the plastic structure when released in the soil negatively affect the soil ecosystem and in turn the human health **[6]**. Due to abundance in natural environment, plastic is transported from land to river, and eventually reaches the ocean in the form of microplastics **[7]**. Plastic debris affect at least 267 animal species worldwide, including 86% of all sea turtle species, 44% of all seabird species, and 43% of all marine mammal species. Significant amount of toxic heavy metals like copper, zinc, lead and cadmium recovered from plastic wastes from sea shores have an adverse effect on the coastal ecosystems. Lead and cadmium pigments, commonly used in most of the plastics as additives are hazardous in nature and are known to leach out. Several Green House gases are emitted from the plastic landfills among them; carbon dioxide and methane constitute 90 to 98% **[8]**.

India, a lower-middle income country of Asia consumes an estimated 16.5 million tonnes of plastic and is responsible for generating 9.46 million tonnes of plastic waste annually of which 40 per cent remains uncollected, as per the recently published study by Un-Plastic Collective (UPC). 43% of plastic manufactured in the country is for single-use packaging material that will mostly find its way into garbage bins after use and is most contributor of plastic pollution mostly. India generates so much plastic waste because of the vast network of unlicensed units manufacturing low-grade plastic bags, inadequate waste management system and import of plastic waste despite oversupply in India before the re-imposition of import ban in March 2019 **[9]**. Realizing the menace of plastic, efforts to reduce the use of plastics and to promote plastic recycling has occurred. 60% of the total plastic waste is being recycled in India, the remaining 40% is either land filled or go into the natural environment, where plastics accumulate and persist for a long period of time. Plastic Waste Management Rules 2016 mandated the producers and brand owners to devise a plan in consultation with the local bodies to introduce a collect-back system. This system is known as the Extended Producers Responsibility (EPR). Central Pollution Control Board (CPCB) has estimated the collection efficiency as 80.28% in 2014, out of which only 28.4% was treated. Remaining quantities were disposed in landfills or open dumps affecting the ecosystem in India **[8]**.

The present study is carried out in an Indian state capital of Madhya Pradesh, Bhopal which produced 50457.07 Metric tonnes of plastic waste during 2017-18. Plastic carry-bag use and production is banned in the state since May 24, 2017 as per National Green Tribunal (NGT) instructions. But via access hatch Madhya Pradesh is still importing plastics from other states and is contributing in the littered plastic **[10]**. Bhopal which is the capital of the state is the 16thlargest city in the country and 131stin the world. The population of Bhopal as per Census 2011 was 1798218.

The city is located in the central part of state within North Latitude of 2316’ & East Longitude 7736’ having temperature range of minimum 2.5°C to maximum 45°C. Bhopal generated approx. 1055 MT of Municipal Solid Waste (MSW) per day in the year 2019 in which around 137.15 MT (=13%) was plastic waste. Approximately 60-70% of the total waste is dumped in an open landfill in an area at Bhanpur, 12 km from city boundary. Bhopal Municipal Corporation (BMC) is responsible for solid waste management of the city. MSW in Bhopal contains mixed wastes that include domestic wastes from homes, expired goods, agricultural wastes, clothes rage and hospital wastes most of which are or come in polyethylene carriers. No scientific method of waste disposal is adopted here as per the Bhopal Municipal Solid Waste Private Limited report **[11]**.

Plastic which takes much longer time to degrade in the environment due to high polymer nature, may take years to centuries for degradation. Recently, bioremediation of plastic waste is considered as an economic and environment-friendly strategy for plastic waste management that could totally reduce the severe pollution produced from the conventional plastic remediation methods. Both fungi and bacteria have demonstrated their remarkable ability for plastic degradation by some studies. But the microorganism which can degrade plastic in no time is still a dream for the researchers working in the field. Fungi could be efficient organisms for the biodegradation of plastics because they are capable of attaching to the hydrophobic surface of the polymers **[12, 13]**, can produce extracellular enzymes targeting insoluble fibers, and also continue to exist in stressful growth conditions **[14]**. Only few fungal species have been investigated for their plastic degradation ability but there are as many as 5.1 million fungal species that exist on earth and has not been explored at all. So this area needs exhaustive work in different regions of the world so that the cumulative studies can help in uncovering the fungi which has the potential to deteriorate plastic.

The current investigation is one of its kind as per our knowledge in the state of Madhya Pradesh were we have isolated 30 fungal species from 35 years old open municipal landfill of Bhopal expecting to acquire fungi which is able to degrade plastic in vitro at faster rate. This is the pioneer study at the site from where we have isolated and characterized morphologically and microscopically potential plastic degrading fungi.

MATERIAL AND METHODS

Sampling Site and Collection of Soil Samples

The sampling site is an open landfill operating since 35 years known as Bhanpur Khnati located at Bhanpur, 12 km from city boundary. Bhanpur khnati (Dumping area) is spread across **57.8 Acres** of land. The untreated waste of the city is directly dumped here with any scientific processing. A total of 10 soil samples were randomly collected from land fill site at the 15 cm depth using a sterile spatula in a disinfected zipper bag, labeled and transported to laboratory and stored for further microbial analysis at 4^0C. The soil samples were collected from the site with large amount of plastic waste which had been buried for a long time. The sites were selected for increasing the probability of finding fungi that can degrade polythene (plastic) under natural conditions **[15]**.

Physicochemical characterization of soil samples

Temperature and color of the soil sample was recorded on the spot. The electrical conductivity is measured through electrical conductivity meter. Organic content and pH of the soil samples were measured according to standard procedure as given below:

Organic content of soil samples:

The determination of organic content in soil samples was done using loss-on-ignition (LOI) method. One gram of each soil sample was first dried at 105ºC overnight. Samples were weighed after dryness and then were heated at 550ºC in a muffle furnace. The samples were weighed again after cooling them in a desiccator. Organic matter content was calculated according to the following equation [16]: W2 - W1 / W1*100 {W1 (dry weight before ignition); W2 (weight after ignition)}.

pH of soil sample:

Soil samples were dried at 60 ^{0} C for 72 h, powdered in pestle and mortar and filtered through 2 mm sieve and the sieved soil was dissolved in distilled water (2.5w/v) and vortexed for 5 minutes at 120 rpm then the pH was measured by digital pH meter **[17]**.

Mycoflora isolation

One gram of each soil sample was mixed aseptically in 9 ml of sterile distilled water and shaken vigorously. Appropriate tenfold serial dilution was made and 0.1 ml of the dilution was transferred aseptically to sterilized Petri plates, containing growth media. For mycobiota analysis, freshly prepared potato dextrose agar (200 g peeled potatoes, 20 g agar and 15 g agar in 1,000 ml of distilled water) and Czapek dox agar medium (2 g $NaNO_2$, 1 g K_2HPO_4, 0.5 g $MgCl_2$, 0.5 g KCl, 0.01 g $FeSO_4$, 30 g sucrose and 15 g agar in 1000 ml distilled water) were used. Triplicate of each sample were incubated at 25 ± 2°C, for 7 to 15 days and examined visually as well as under compound light microscope daily for preliminary identification of fungal genera. The identified genera were then sub-cultured on suitable agar plates for species identification preserved in slants at 4^0C **[18]**.

Macroscopic and microscopic identification

Identification of fungal species was done on the basis of cultural and morphological characteristics. Macroscopic features like surface color, margins, reverse side, elevation and growth rate, as well as microscopic such as size of conidia and conidiophores and their arrangements were examined for species differentiation **[19-21]**.

Statistical analysis

The analysis of data was performed with Microsoft excel 2007(Windows XP) for mean and standard deviation. Descriptive analysis of percent relative frequency for fungal isolates was performed on the collected data **[22]**.

RESULTS

Characterization of physiochemical parameters of soil samples:

The physiochemical properties of soil used for isolation of fungal species were analyzed in the present study. The color of soil samples was brown to black, with variation in pH (5.39 - 5.88). The temperature of the soil was high (30.4^{o}C – 33.2^{o}C) and the variation in percent organic content was found to be (0.15 – 0.35). Soil properties like organic matter, pH and moisture content etc., affects the density and diversity of fungi in the soil. The moisture content in soil acts as solvent and is essential for fungal functioning.

Isolation and characterization of fungal strains:

In present study 16 different types of fungal species were isolated from soil samples.

Morphological and microscopic characteristics were studied for identification of all isolates, along with available literature. The isolates were identified as filamentous fungi belonging to the phyla Ascomycota. Among the isolated *fungal* species, highest frequency was observed is of *Penicillium chrysogenum complex* (16.44%) and *Aspergillus flavus (15.06%), while the lowest frequency was of Trichoderma viridae, Penicillium citrinum and Aspergillus clavatus (1.37%).* The % Relative frequency of the different fungus obtained using standard pure culture techniques is represented in **Figure 1**. The photomicrographs of all the fungal isolates helped in identification of the fungal species **(Figure 2a and 2b)**. The cultural characteristics and the sporulating structures of these isolates are presented in **Table 1** and **Figure 3a, 3b and 3c** respectively. The microscopic characteristics of different fungal species are represented in **Table 2a and 2b**.Analysis of different *fungal* species isolated from soil samples for morphological and cultural characteristics showed that there was variation in the colony surface color, elevation, reverse side, margins and growth rate as well in the microscopic structures.

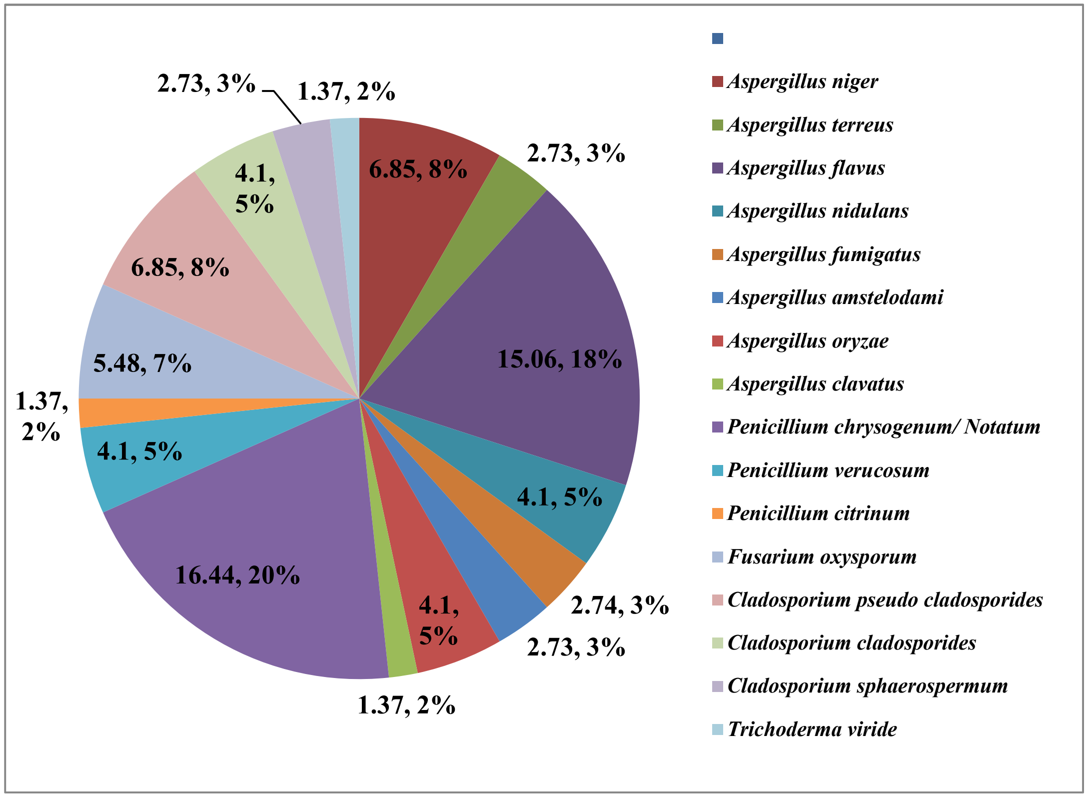

Figure 1: % Relative frequency of fungi isolated from soil samples collected from Bhanpur Dumping Site, Bhopal, India

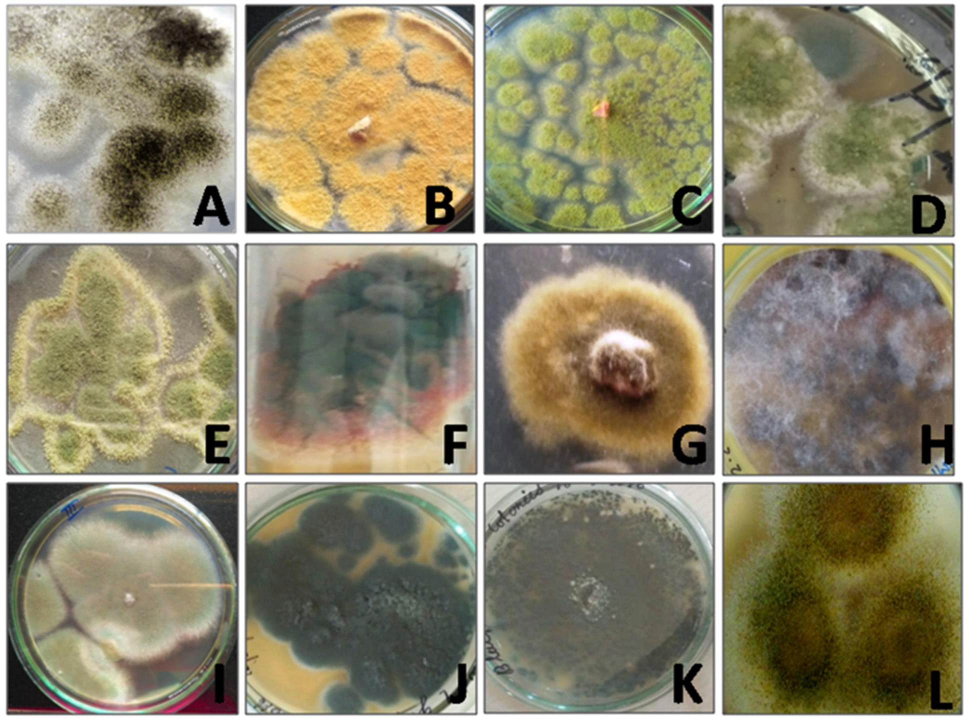

Figure 2a: Colonies of Fungi on Czapedox agar Media : ***Aspergillus niger*** **(A),** ***Aspergillus terreus*** **(B),** ***Aspergillus flavus complex*** **(C-E),** ***Aspergillus nidulans*** **(F),** ***Aspergillus amstelodami*** **(G),** ***Aspergillus clavatus*** **(H),** ***Aspergillus fumigates*** **(I-K),** ***Aspergillus oryzae complex*** **(L)**

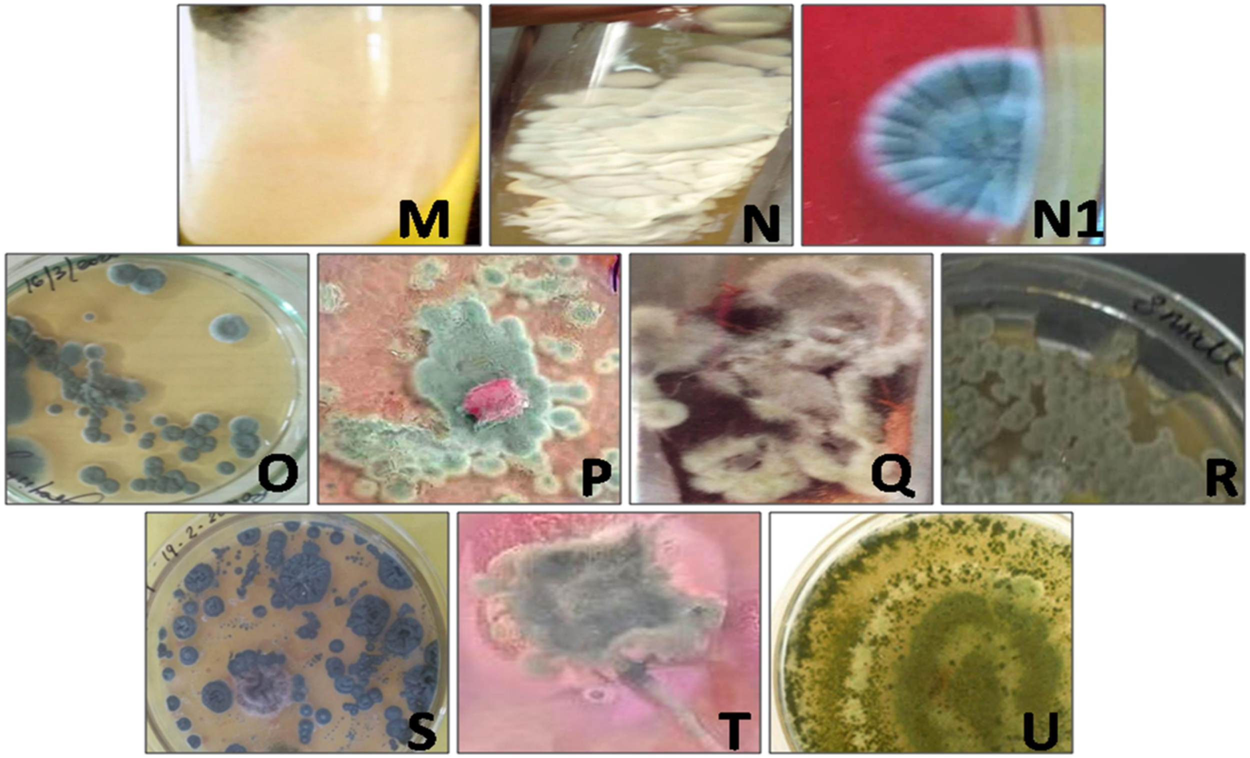

Figure 2b: Colonies of Fungi on Czapedox agar Media(CZ) and Rose Bengal Media (RB): ***Fusarium oxysporum*** **(M-M1) ,** ***Penicillium chrysogenum complex*** **(N) & (N1-RB),** ***Penicillium notatum/chrysogenum complex*** **(O),** ***Penicillium citrinum*** **(P),** ***Penicillium verrucosum*** **(Q),** ***Cladosporium pseudo cladosporioides*** **(R),** ***Cladosporium sphaerospermum*** **(S),** ***Cladosporium cladosporioides*****(T),** ***Trichoderma viridae*****(U)**

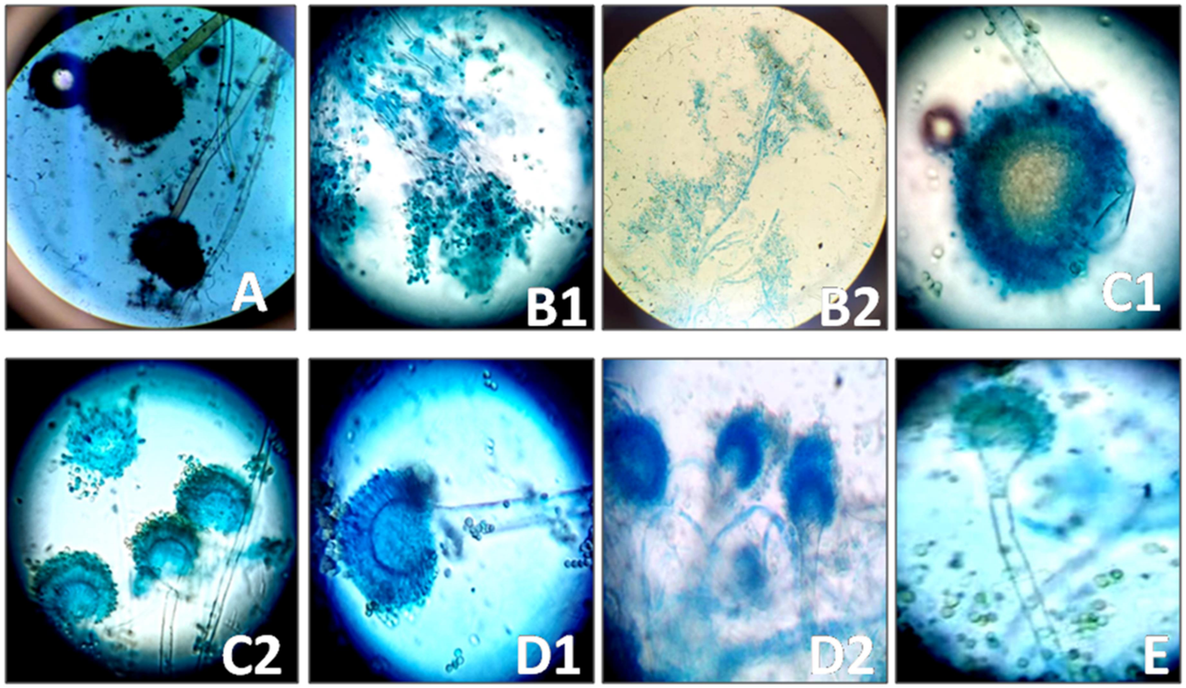

Figure 3 a: Microscopic View: ***Aspergillus niger*** **(A),** ***Aspergillus terreus*** **(B1-B2),** ***Aspergillus flavus*** **complex (C1-E)**

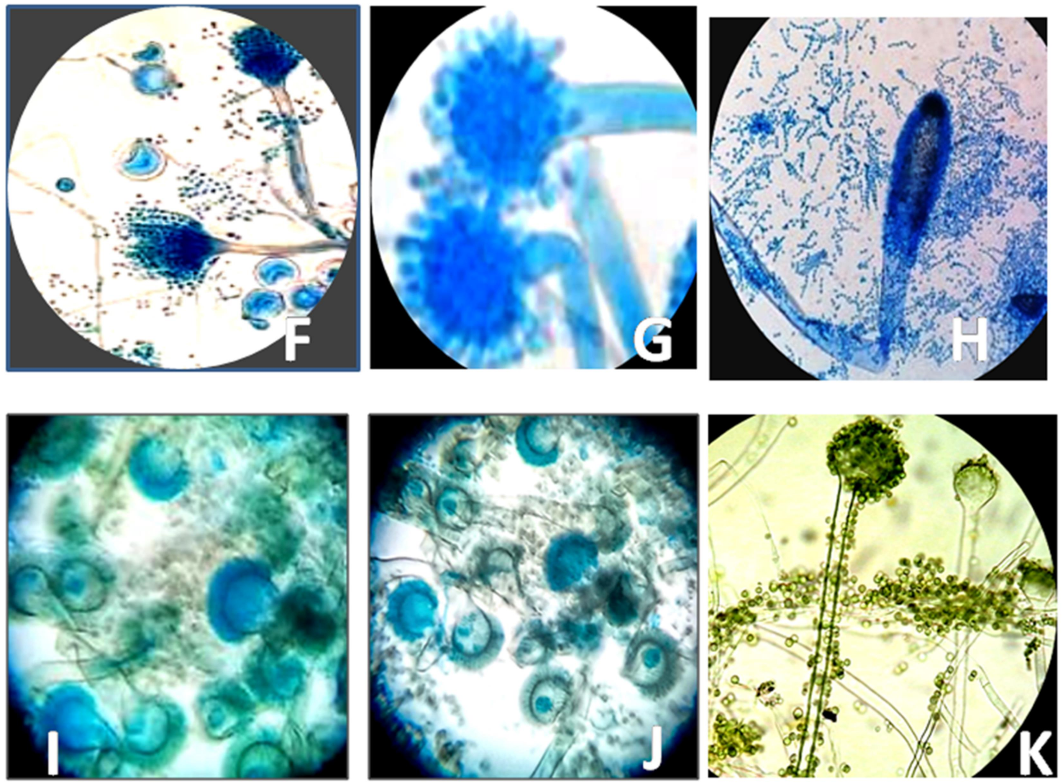

Figure 3b: Microscopic View: ***Aspergillus nidulans*** **(F),** ***Aspergillus amstelodami*** **(G),** ***Aspergillusclavatus*** **(H),** ***Aspergillus fumigates*** **(I-J),** ***Aspergillus oryzae*****(K)**

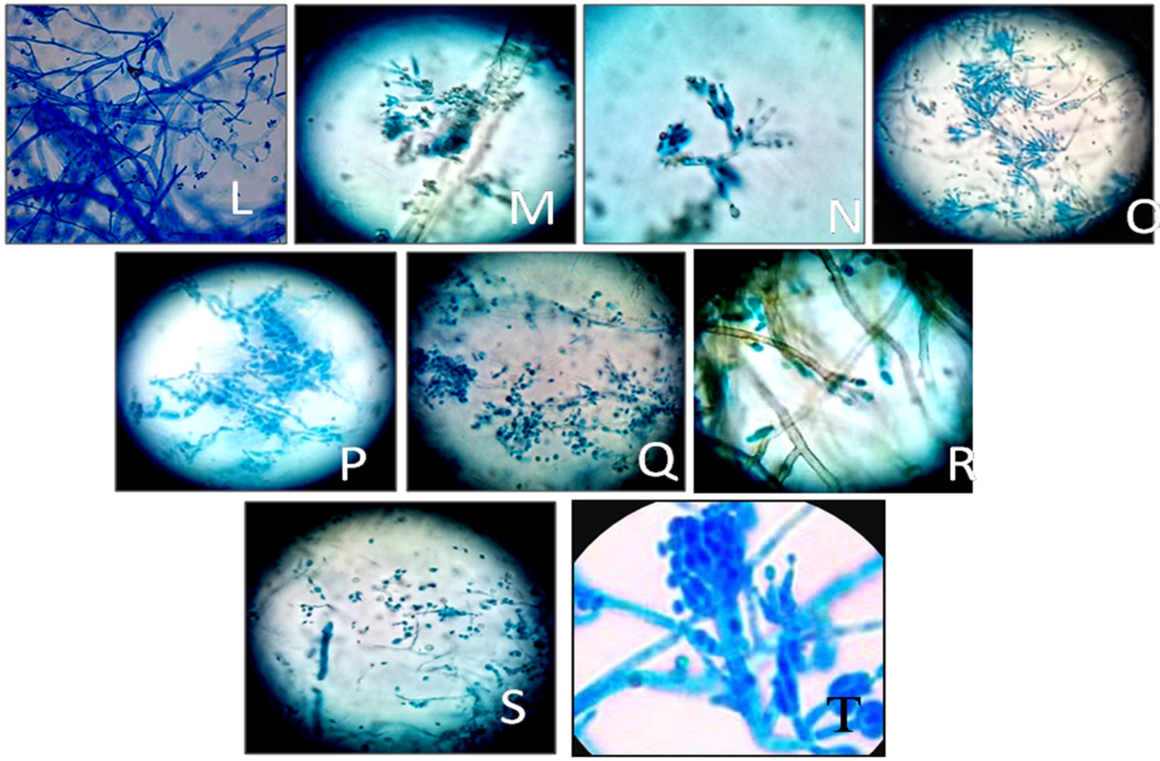

Figure 3c: Microscopic View: ***Fusarium oxysporum*** **(L),** ***Penicillium chrysogenum*****(M) ,** ***Penicillium notatum/chrysogenum*****(N),** ***Penicillium citrinum*** **(O),** ***Penicillium verrucosum*** **(P),** ***Cladosporium pseudo cladosporioides*** **(Q),** ***Cladosporium sphaerospermum*** **(R),** ***Cladosporium cladosporioides*****(S),** ***Trichoderma viridae*****(T)**

Table 1: Morphological/Cultural characteristics of different fungal isolates

S. No.	Fungus	Morphological characteristics				
		Surface colour	Margins	Reverse side	Elevation	Growth
1.	*Aspergillus niger*	Dark brown to black	Entire	Without colour	Umbonate	Rapid
2.	*Aspergillus flavus*	Yellow/ greyish green	Entire	Colourless to yellow	Umbonate	Moderate to rapid
3.	*Aspergillus fumigatus*	Green to dark green, becoming black with age	Entire	Colourless to yellow	Umbonate	Rapid
4.	*Aspergillus terreus*	Brown with floccose become dark with age	Entire	Pale to bright yellow to deep brown	Umbonate	Moderate to rapid
5.	*Aspergillus nidulans*	Dark cress green	Entire	Purplish red, brownish dark with age	Umbonate	Slow to moderate
6.	*Aspergillus amstelodami*	Dark green	Entire	Brownish red	Umbonate	Very slow
7.	*Aspergillus calvatus*	Bluish to grey green with appearance of floccose	Entire	Without color becomes brown with passing time	Flat	Rapid
8.	*Aspergillus oryzae*	Green to brownish	Entire	Colourless to yellow	Umbonate	Moderate to rapid
9.	Penicillium chrysogenum complex	Initially white and become blue green, gray green, olive gray, yellow or pinkish in time	Entire	pale to yellowish	Umbonate	Moderate
10.	Penicillium citrinum	Central greyish-turquoise to greyish-orange colour with a white periphery (outer edge).	Entire	pale yellow to a light yellow-brown	Raised	Slow to moderate
11.	Penicillium verrucosum	white mycelium and greyish-green to dull green conidia	Entire	yellow brown to deep brown	Raised	slow-growing
12.	Trichoderma viridae	green-colored colonies surrounded by an oscillating white mycelium.	Entire	amber or uncoloured	Umbonate	Moderate
13.	Fusarium oxysporum	initially white but later becomes purple, with discrete orange sporodochia (mass of hyphae)	Entire	Light violet/ pink to pale orange	Umbonate	Rapid
14.	*Cladosporium pseudo cladosporioides*	olive-grey to dull green, velvety and tufted	Entire	olivaceous-black.	Umbonate	Moderate
15.	*Cladosporium cladosporioides*	olive-grey to dull green, velvety colonies with white edges	Entire	olivaceous-black.	Umbonate	Rapid
16.	*Cladosporium sphaerospermum*	olive-black or olive-brown in colour. velvety	Entire	olivaceous-black.	Umbonate	Slow

Table 2a: The Microscopic characteristics of different fungal species

Characteristics		*Aspergillus niger*	*Aspergillus flavus*	*Aspergillus fumigatus*	*Aspergillus terreus*	*Aspergillus nidulans*	*Aspergillus amstelodami*	*Aspergillus clavatus*	*Aspergillus oryzae*
Hyphae		Branched septate	Branched septate	Branched septate	Branched septate	Branched septate	Branched septate	Branched	Branched
Conidiophore									
1.	Length	200 to 400µm	600 to 800 µm	250 to 300 µm	150 to 250µm	60 to 150 µm	200 to 350 µm	1.5-3 mm	1–5 mm
2.	Diameter	7 to 10 µm	15 to 20 µm	2 to 8 µm	5 to 8 µm	8 to 12 µm	7 to 10 µm	20-30 µm	20-25 µm
3.	Vesicle	Globose	Globose to subglobose	Dome shaped	Globose	hemispherical	globose	Club-shaped	Globose to radiate
Conidia		30 to 75 µm	20 to 45 µm	20 to 30 µm	2 to 3µm	8 to 12 µm	3.9 to 4.2 µm	150-400 µm	100–200 µm
1.	Heads	Blackish brown	Yellow/greyish green	Blue green	Creemish	Cinnamon brown	Yellowish green	Artemesia green to slate olive	yellowish green to greenish brown
2.	Diameter	2.5 to 4 µm	2 to 6 µm	2.5 to 3 µm	2 to 5 µm	3 to 3.5 µm	4 to 7 µm	2.5–4.5 µm	5–8 µm
3.	Ornamentation	Spiny	Almost Smooth	Roughened	Smooth	Almost Smooth	Roughened	Smooth	Smooth to finely roughened
Phialides		Two series (Biseriate) covering entire vesicle	Two series (Biseriate) covering nearly entire vesicle	Single series (Uniseriate) covering only upper portion of vesicle	Two series (Biseriate) covering only upper portion of vesicle	Two series (Biseriate) covering only upper portion of vesicle	Single series (Uniseriate) covering nearly entire vesicle	Single series (Uniseriate) covering only upper portion of vesicle	Single series (Uniseriate) But some contains metulae and phialides (biseriate sterigmata)
1.	Primary	20 to 30 µm	7 to 10 µm	6 to 8 µm	7 to 9 µm	5 to 6 µm	40 to 60 µm	40–60 µm	5-6 µm
2.	Secondary	40 to 60 µm	7 to 10 µm	Absent	5 to 7 µm	5 to 6 µm	Absent	Absent	Absent (if present approx 3 µm)
Fruiting bodies		Cleistothecia present	Cleistothecia present	Cleistothecia present	Cleistothecia absent	Cleistothecia present Hulle cells present	Cleistothecia Present	Cleistothecia Present	Cleistothecia Present

Table 2b: The Microscopic characteristics of different fungal species

Characteristics		*Penicillium Citrinum*	*Penicillium Notatum/Chrysogenum*	*Penicillium Verrucosum*	*Trichoderma Viridae*	*Fusarium Oxysporum*	*Cladosporium pseudocladosporioides*	*Cladosporium Cladosporioides*	*Cladosporium Sphaerospermum*
Hyphae		Branched, Septate	Branched, Septate	Branched, Septate	Branched, Septate	Branched, Septate	Unbranched or Rarely Branched	Unbranched or Rarely Branched	Branched, Septate
Conidiophore									
4.	Length	100 – 300 µm	87-287 µm	100 – 400 µm	52-120µm	-	40–300 µm	40-300 µm	150–300 mm
5.	Diameter	2.8-5.1 Mm	1.5 To 5 µm	3.0-4.0 µm	7.- 11.5µ	-	2–6 µm	2.5-3.5 µm	3.5–4.0 mm
6.	Metulae	Biverticillate	Biverticillate	Biverticillate/ Terverticillate	-	-	-	-	-
	Length	15-23 µm	3-12 µm	Appressed	-	-	-	-	-
	Diameter	2-5 µm	2.5-3.5 µm	-	-	-	-	-	-
Conidia									
4.	Heads	Grayish-Turquoise	Greenish	Greyish-Green to Dull Green	Green	Pinkish Purple	Grey, Buff or Brown	Olivaceous Brown	Grey/Green
5.	Diameter	2.2 – 3.0 µm	2.5-5µm	3 mm to 4 mm	3-6µm	Macroconidia : 23-54 X 3-4.5 µm Microconidia: 5-12 X 2.3-3.5 µm Chlamydospores: 5-13 µm	1-4 Ramoconidia: 7-38 X 2-5 mm in Length	1.8-2.4 Ramoconidia: 12-15 X 2.5-3.5 mm in Length	3.4–4.0 mm Ramoconidia 6–14 × 3.5–4.0 mm in Length
6.	Ornamentation	Smooth or Finely Roughed	Smooth or Rough-Walled	Smooth-Walled	Smooth- or Rough-Walled	Smooth-Walled	Smooth-Walled	Smooth walled	Smooth Walled
Phialides		Ampulliform	Flask-Shaped Phialides	Flask-Shaped With Distinct Necks	Ampulliform to Flask-Shaped	Cylindrical	Ampulliform	Flask-Shaped Phialides Arranged in Groups From Branched Metulae Forming A Penicillus	Flask-Shaped With Distinct Necks
3.	Primary	7-10 µm	7-9 µm	7-9 µm	4.8–8.5 µm	10-20 µm	-	-	-
4.	Secondary	2-2.5 µm	2-2.5 µm	2-2.5 µm	2.5-3.5 µm	2.0-4.0 µm	-	-	-
Fruiting bodies		Cleistothecia present	Cleistothecia present	Cleistothecia present	Cleistothecia present	Cleistothecia present	Cleistothecia Present	Cleistothecia Present	Cleistothecia Present

DISCUSSION

In the present study we have isolated 5 Genus of fungi belonging to phylum Ascomycota and as many as 30 fungal species from the dumping site of Bhopal polluted with various type of plastic. This is the first report of its kind where different fungal species capable of plastic biodegradation has been studied from the Bhopal which is the capital of the state Madhya Pradesh, India, having dumping turnover of 1055 MT annually. These species of fungi probably degrade multiple types of plastics through the formation of Biofilm on the surface of plastic polymers where symbiotic relationship exists of biodegradation as well as nutrient utilization of carbon.

The most apparent plastic deteriorating fungal isolates found in abundance at the site of sample collection rich in plastics were identified as *Penicillium chrysogenum complex* with highest frequency that is 16.44% followed by *Aspergillus flavus (15.06%),* while the lowest frequency was of *Trichoderma viridae, Penicillium citrinum* and *Aspergillus clavatus (1.37%). The* other fungi that are *A. niger, A. terreus, A. nidulans, A. fumigates, A. amstelodami, A. oryzae, Penicillium verucosum, Fusarium oxysporum, Cladosporium pseudo cladosporides, Cladosporium cladosporides* and *Cladosporium sphaerospermum* were found between the range of 2.73% to 6.85%.

In the present study we have found that the majority of fungal species particularly *Aspergillus flavus*, *Penicillium chrysogenum complex*, *Cladosporium pseudo cladosporides* and *Aspergillus niger* penetrate into the plastic polymer attached to the substrate leading to its rapid degradation. The present data reflect the high potential of these fungal species for rapid biodegradation which has commercial applications if exploited properly.

Ojha *et al* **[24]** has isolated and screened *Penicillium oxalicum* and *Penicillium chrysogenum* from the soil collected from plastic dumping ground near Kolkata having plastic degradation abilities. Also *Aspergillus Flavus, Aspergillus versicolor* & *Fusarium solani* were isolated from local municipal dump yard from Chennai which were screened to have plastic degrading potential **[25]**. We have isolated as many as 30 fungal species which are highly varied in characteristics, as they all were present at the plastic polluted site, the chances of almost all of them to degrade plastic and utilize it as carbon source increases. Amongst the isolated fungal species many are not investigated for their capability of plastic degradation until now. If these fungal species are screened for probability of finding efficient fungi which can degrade plastic at highest speed it would be highly helpful for the researches going around the globe on the similar area. We are working on the same line of screening the most efficient amongst them, the work in our laboratory is in progress.

CONCLUSION

In the present investigation thirty fungal strains were isolated from plastic contaminated soil of Bhanpur Khanti (Dumping site) Bhopal, MP, India. Out of which 16 were identified after staining with lacto phenol cotton blue based on their morphological characters and microscopic analysis. Most of the fungal species were able to grow efficiently and appear concurrently throughout the isolation process, indicate that these indigenous fungi may have the capacity to adapt plastic as novel growth and energy substrate.

Declarations

Funding agency: None

Conflicts of interest/Competing interests: None

Code availability: Not applicable

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