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A study on the ability of some fungi isolated from oil soil contaminated to biodegradation plastic and paper waste in Kirkuk city

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Abstract

This study was carried out in department of life science at the University of Kirkuk, College of Education for Pure Science laboratories to determine the capability of some types of fungi isolated from oil soil contaminated samples taken from different areas of Kirkuk city and to evaluate the biodegradation effect of plastics and papers wastes. The results showed that after taking 50 oil soil samples, the following fungi were isolated: The molds found were *Aspergillus spp, Penicillum spp* and *Alternaria spp*. Their impact on seven categories of waste was assessed as the weight was determined for each piece. The overall effect from the project was the reduction on the weight, Among the fungi, *Alternaria spp* outperformed *Aspergillus spp*, *Penicillum spp* and the wastes that lost the most weight after the fungi grew on them were cardboard, coffee cup, and drawing paper.

Keywords: Biodegradation; Fungi; Oil soil; Plastic; Kirkuk

1. Introduction

The use of plastic products in modern life is significant and indispensable; it is difficult to find a product that does not contain one of the types of plastic, but the growing and cumulating quantity of plastic waste and the negative impact on people and the earth led the increasing of the attention to the problem in many countries of the world. Investigations show that as much as 3 - 5% of the total global production of crude oil is used in the production of plastics (1) and in the year 2012 alone, world production of plastics stood at 280 million tons. A massive proportion that was produced in most industries and half of it subsequently ended up in the continents of the world and the seas and oceans in form of garbage (2).

Of polymers, plastics are generally communicated based on the chemical structure that embraces the backbone as well as the polymer side chains(3). However, the technological classification of plastics in terms of the effect of heat on them is and is divided into two types: Thermoplastics are the first of which, a family of plastic materials that have linear molecular structure that can be plasticized by heat and re-hardened by cold . These materials are characterized with one of the features: after several cycles of heating-cooling, they lose their plasticity. Plastic is mostly consumed from known thermoplastic, which is the type of plastic that can be recycled in about 80%. The second one is classified as thermosetting plastics which are made up of (4).

It is a kind of plastic material having both copolymer and polymer molecular structure the does not have the ability to be hardened and reshaped again and again (5).

Biodegradation of synthetic plastics by fungi is believed to have occurred due to metabolic adaptation following long duration exposure of fungi to xenobiotic polymers produced in the environment through human influence (6).

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While, for biodegradation, they are biodegradation and bio degradation, but the manner in which they happen differs. The former is biodegradation; the latter bio degradation. The former involves action of microorganisms like bacteria and fungi on this object to bring about degradation; the latter is just direct degradation of the object by the microorganisms with the help of pressure, pH, temperature and other circumstances. In this case, some pro – oxidant ions such as cutinase, lipase, proteases, carboxylesterases, esterases, and lignocellulolytic enzymes, will degrade plastic(7). The oxidation hydrolysis enzyme increases the water affinity of polymers and leads to the breakdown of macromolecular polymer into micro molecular .Mainly large compound has high molecular weight that cannot be transferred through the cellular membrane of fungi so high molecular weight breaks large compound down to small monomers so it doesn't cross the cell membrane (8).

2. Material and methods

2.1. Preparing the culture media

2.1.1. Potato Dextrose Agar

Boil finely grated potatoes in 500 ml of water until completely cooked (about 1 hour); strain via cheesecloth, and dilute the filtrate with water to 1000 ml (9) .

2.1.2. Czapek Dox Agar

Dissolve Czapek Dox Agar to 1000ml distilled water with adding 49g of Czapek Dox Agar. This should be boiled to ensure total melting of the medium to ensure a perfect mixture. Sterilize the swab by autoclaving at 15 pounds pressure (121°C) for fifteen minutes (10) .

2.1.3. Sabouraud-dextrose broth

After first dissolving 30g of them in 1 liter of water (purified if necessary). Blend thoroughly, portion out into the final packaging and sterilize by heating at (121 °C) for 15 min.

2.2. Source of isolation

Therefore, local fungi were isolated from some areas of the oil soil (oil soil brought from oil station like the oil soil existing around the gasoline or diesel pump. So, some oil derivatives spilt on the soil or by sweeping around the gasoline or diesel pump collected and then brought on us oil soil which is black by a soil drill in sterile way and brought to a laboratory within 48 hours of collection).

2.3. Isolation of fungi

10 tubes were washed and sterilized, 99 ml of distilled water was placed in 250 mm flask, covered and sterilized at a temperature of 121°C.

Taking 10 grams of sample is contaminated oil soil, placed in the flask having 99 ml of distilled and sterile water shaken well, and at last we take 1 ml and put in the first sterile tube, then taking from the first tube and putting it in the second, and then repeated the sample 10 (11) .

Initiated into sterile petri dishes Potato Dextrose Agar medium and Czapek Dox Agar medium, then leaving until the medium solidifies, took 1 mm from the first tube (water + soil), using sterile pipette and placed in the first dish and incubated at 20degC.Later, Incubation Examination of the dishes and selection of 3 colonies which gave good fungal characteristics. was taken from the first tube (water + soil) using a sterile pipette and placed in the first dish incubated at a temperature of 20. After a period of time Incubation Examination of the dishes and selection of 3 colonies that gave good fungal characteristics. Using a microscope, the type of fungus within the colony was determined to be *Penicillium spp., Alternaria spp*. and *Aspergillus spp.* (12).

2.4. Preparation of plastic and paper waste

According to the definition we collected 7 different samples of plastic and paper material cut all samples to 2cmx 2 cm, and dried them in the oven at 45°C . Dry the samples for one day and weigh them, record the sample and weight with each sample.(13)

2.5. Growing fungus on plastic and paper waste

The isolated fungi *Pancilium spp* , *alternaria spp* and *Aspergillus spp* were taken and placed in a beaker with the control treatment (medium and sample only) and with sterile forceps taken out the best growth of the isolated fungi were placed in a beaker containing the liquid medium (Sabouraud dextrose broth) (14). After two to four weeks of the experiment, the samples were placed on a vibrating device and readings were taken. Weighed the samples with a sensitive balance to 0.0000 (15).

3. Results and Discussion

In the present study the effectiveness of some of the fungi isolated from oil soils of different areas of Kirkuk city was tested in the analysis of regular plastic waste as 38 positive isolates were isolated from 50 introduced samples. They were isolated as three possible different genera after microscopic examination (Fig. 1) ; (*Aspergillus spp* and *Alternaria spp* and *Penicillium spp*). It was noted that the genus *Aspergillus* dominated, as it appeared in all study sites. The reason for this is the wide spread of species of this genus and the large quantities of conidia that they form (16).

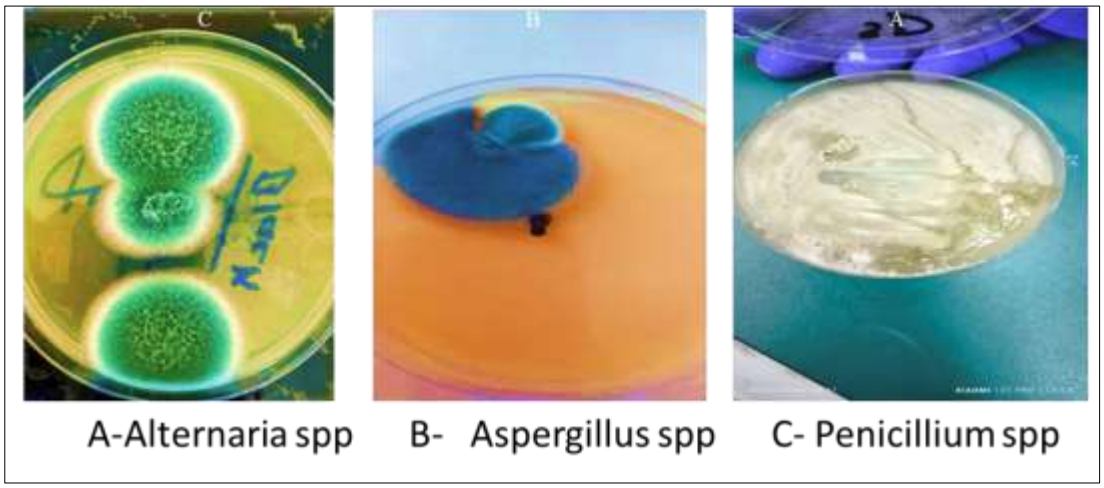

Figure 1 Fungi isolated from oil soil contaminated

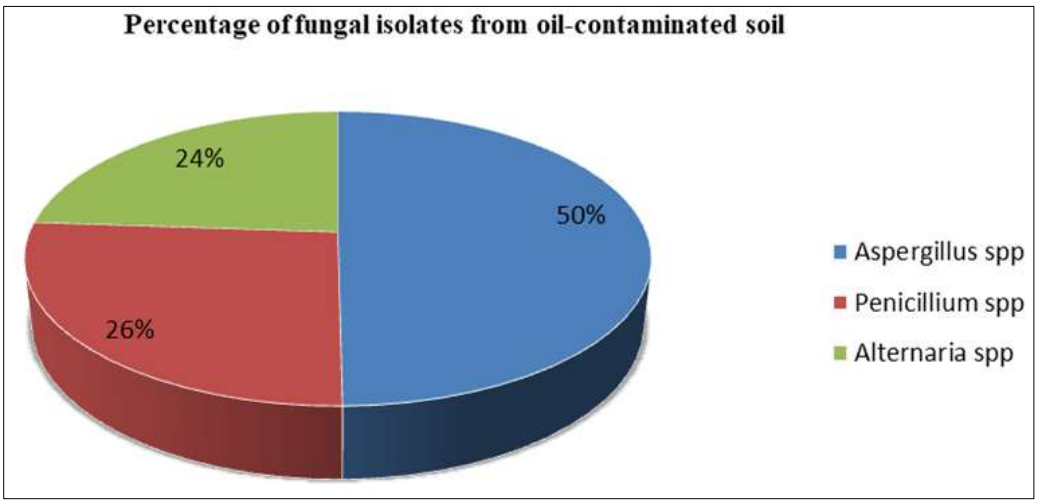

Figure 2 Percentage of positive fungal isolates from oil-contaminated soil

As shown in Table 1, there results obtained and demonstrated how the best isolated fungi were able to grow in the medium from the analysis of plastic and paper waste.

Table 1 The ability of the isolated fungi form oil soil contaminate to analyze plastic samples

Penicillium spp		*Alternaria spp*		*Aspergillus spp*		*sample*
After Weight gram	**Before Weight gram**	**After Weight gram**	**Before Weight gram**	**After Weight gram**	**before Weight gram**	
0.4220	0.4790	0.3500	0.4678	0.3459	0.4566	**Cardboard**
0.6309	0.6900	0.5567	0.6790	0.6068	0.6689	**Drawing paper**
0.7960	0.8190	0.7001	0.8889	0.7146	0.8998	**Coffee cups**
0.7790	0.6890	0.5890	0.5432	0.7900	0.6990	**Water bottle**
0.3982	0.3451	0.3045	0.2890	0.2698	0.2560	**Clear cup**
0.3749	0.3179	0.4045	0.3891	0.3890	0.3678	**Clear bag**
0.3897	0.3610	0.3349	0.3009	0.2666	0.2567	**Black nylon**

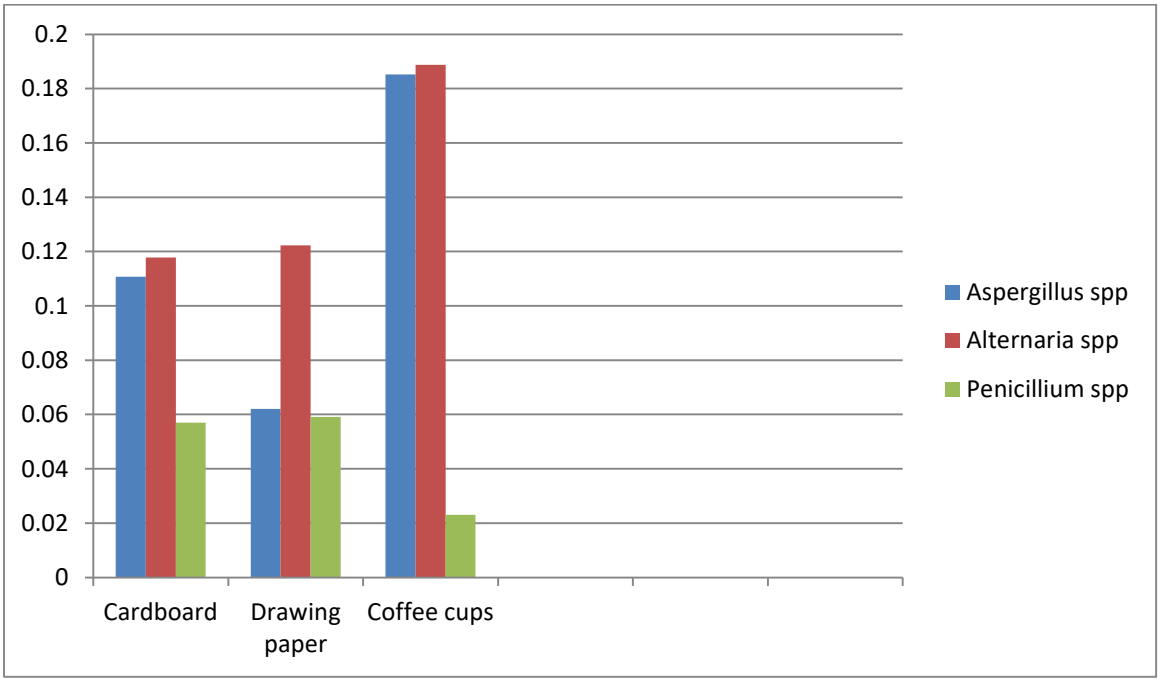

Figure 3 The total weight differences between the fungi studied on cardboard, coffee cup, and drawing paper.

Results showed that growth of each of the Water bottle and Clear cup and Clear bag and Black nylon increased weight when grown with the tested fungi , which can be attributed to the absorption of water by polyethylene, surface density and volume of the sample increasing (17).

Analysis of the tested fungi for samples of the cardboard, coffee cup, drawing paper were performed. This is because fungi have been indicated in many studies to be able to analyze these compounds owing to their high content of cellulose in manufacturing processes (18).

Ability of fungi to convert multiple starch polymers also. As shown in Figure 3, the efficiency of *Alternaria spp* fungi compared to *Penicillium spp* and *Aspergillus spp* fungi due to the high ability of *Alternaria spp* fungi to produce enzymes that can break down plastic wastes and known as (PET hydrolytic enzymes)(19).

These results show that fungi have an important role to play in analyzing plastic waste, in this case soil fungi that employed waste as a major source of carbon (20).

The enzyme of microbial origin on the plastic surface mediate the mechanism of biodegradation of plastics. The bacteria and fungi then attach to the cells, both literally and literally (the bacteria does indeed use enzymes to 'inert' them and grow over them using the plastic as a substrate and a source of nutrition). For these polymers, therefore, degradation will be 'compounded', 'compiled', by mineralization to end products including H2O (water), CH2 (methane), CO2 (carbon dioxide) (21). In contrast, fungi were able to invade substrates with enzymes that can detoxify pollutants (22). Fungi also produce some surface active proteins (hydrophobins) that can also be used to cover over hyphae on the surface acting hydrophopbic substrates.Furthermore, some fungi are able to colonize the polymer solids and cause small scale swelling and bursting as the fungi penetrate the polymer solids (23)

Similar with other degradations, compared to the biodegradation method is mostly preferred because of its pollution free mechanism and ecofriendly process (24). The involvement of microorganism i.e bacteria & fungi begins the process. In general, however, these conditions for plastic biodegradation also allow for the growth of fungus on plastic and plastic acts as a food source to the fungus in environmental conditions such as temperature and pH(25). However, when these fungal are used in large enough mass they will produce a range of enzymes including cutinase, lipase, proteases, carboxylesterases, esterases, lignocellulolytic enzymes, other enzymes, as well as ion abundances that act prooxidantly to degrade the plastics (26).

4. Conclusion

From the above we conclude that the *Alternaria spp* fungus from oil soils was more efficient to biodegradation plastic and paper waste based on its low weight doubled after growth compared to other fungi. First, we suggest further research on the biological treatment of waste and additional examination of other types fungi, and provide the capability to conduct it.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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