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The cultivation of *Pleurotus florida* mushroom on agricultural wastes to reduce the weight of plastic waste

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The necessity to accelerate the biodegradation strategy to transition to a sustainable plastic waste management approach is growing as environmental plastic waste accumulation accelerates. In the present study, *Pleurotus florida (P. florida)* was cultivated using agricultural waste like rice straw mixed with *P. florida* spawn. Following culture, a sample of mushroom tissue was added to cooled PDA medium on petri dishes, which were subsequently incubated at 25°C. In parallel, low-density polyethylene **(**LDPE) plastic bag fragments with dimensions of 3 cm × 1 cm were exposed to sunlight. Following this time, 50 ml of Dox´s media was inoculated with 2 ml of *P. florida* mycelia suspension and sunlight-exposed LDPE fragments. The effects of carbon concentrations, inoculum doses, temperature, pH, and Tween 80 additives on the weight loss of sunlight-exposed LDPE fragments were studied. Scanning electron microscopy indicated that the LDPE fragment's surface morphology altered after inoculating *P. florida* mycelia. FTIR analysis was newly formed functional groups in the LDPE structure. The weight loss percentage increased with an increase in sucrose concentration and the inoculum dose while decreasing with an increase in temperature, pH, and Tween 80 additives. Also, the colonization of sunlight-exposed LDPE by *P. florida* decreased the tensile strength of the LDPE fragment. These findings confirm that the exposure of LDPE to sunlight facilitated the ability of *P. florida* mycelia to enhance the weight loss percentage of LDPE fragments.

Keywords: Mushroom cultivation, fungal degradation, green methods, polyethylene, plastic waste

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INTRODUCTION

Currently, 367 million tonnes of plastic are manufactured annually worldwide (Li et al., 2023; Plastic Europe, 2020). To put things in perspective, a whopping 9.2 billion tonnes of plastics have been synthesized since their invention circa 1950, of which over 6.9 billion tonnes have ended up as waste. Many of them are single-use plastics, and although they have a minute to hourly lifespan, they can remain in the environment for decades or even centuries. Landfilling (65%), incineration (25%) and recycling (10%) are the most common ways of disposal. They are also used in fuel generation, road construction, deterioration, and biodegradation (Parker and Laura, 2018; Sangale et al., 2019). Plastics are beneficial to industries, but because they lack identifiable enzyme functional groups, they are hydrophobic, and their molecular stability makes them difficult for biodegradation (Sowmya et al., 2015). Plastic waste can take up 20 to 30 percent of the available area in landfills when disposed of, shortening their lifespan and necessitating the construction of new ones. The causes several problems, such as disturbance of the biological balance in certain places and disturbance of the soil due to various wastes (Mahajana and Gupta, 2015). Plastics threaten both marine and terrestrial species when they are improperly disposed of. According to reports, each year the release of plastics into the environment causes the deaths of one million birds and ten million marine species. Moreover, most of the plastic waste is travelling from land to sea and back again, polluting the environment and resulting in bioaugmentation in the food chain (Matija et al., 2021). Furthermore, burning plastics releases harmful gases that worsen air pollution and cause health issues. Recycling is an additional option, but it requires more work, and the public is not as aware of it as it may be (Gajendiran et al., 2016). One of the main persistent plastics discharged into the environment is low-density polyethylene (LDPE), which has a very hydrophobic and refractory tendency.

Long chains of the monomer ethylene (IUPAC name: ethene) make up the polymer polyethylene. Since polyethylene is the most widely used plastic, lowering PE (polyethylene phthalate) would significantly improve the process of cleaning up plastic waste. Findings show that using specific microbial strains to facilitate the biodegradation of plastic waste produced a workable solution (Sivan, 2011). Polythene-based polymers have been reported to be degraded by a variety of microorganisms, including *Rhodococcus ruber*, *Ideonella sakaiensis*, *Brevibacillus borstelensis*, *Serratia sp*., etc. (Ahmed et al., 2018). Around 20% of polyethylene can be broken down in 30 days when microorganisms alone are used, as has been demonstrated in studies conducted all over the world. The degradation of polymers is influenced by various factors, including plasticizers or additives added to the polymer, mobility, tacticity, crystallinity, molecular weight, and the kind of functional groups and substituents present in its structure (Gu et al.,

2015). The ability of the microbe to use the polymer as its only supply of carbon is a precondition for biodegradation. Methylene, the main component of LDPE, is a polymer molecule with an exceptionally high molecular weight that germs cannot enter cells directly. Due to their large role in the breakdown of organic matter in soil and their adaptability in terms of metabolism, most studies show that fungi are very effective at degrading polymers (Zeghal et al., 2021). White-rot fungi (WRF) are a distinct group among these fungi. It is crucial to understand that white-rot fungi are a collection of fungal species that can break down the lignin; they are not a distinct taxonomic group. Instead, they are members of the basidiomycetes class of fungi. *Phanerochaete*, *Pleurotus*, *Ganoderma*, *Bjerkandera*, *Dichomitus*, and *Trametes* are a few of the species of note that belong to this group (Mir et al., 2018; Voberkov et al., 2018). Among the many biodegradation techniques, using white-rot fungi which have enzymes that can change the structure of plastics is a potential strategy. This enzymatic process promotes polymers' bioavailability and speeds up their organic breakdown. The aim of the current work is to reduce the weight of LDPE bags by using the cultivated *P*. *florida* mushroom under various parameters, including sucrose concentration, inoculum dose, temperature, pH, Tween 80, SEM, FT-IR analyses, and tensile strength measurements.

MATERIALS AND METHODS

Materials

Low-density polyethylene plastic bags were kindly obtained by Misr El-Nour company, in the Tenth of Ramadan City, El-Sharqiyah Governorate, Egypt. Low-density polyethylene is used in the production of these plastic bags, according to the manufacturer. *Pleurotus florida* (MLCC No. 14 STCPL-Hong Kong) used in this study was cultivated using rice straw waste and mixed with *Pleurotus florida* spawn (Duration: 18 days, wheat grains used for spawn substrate) which was obtained from the Agricultural Research Centre, Ministry of Agriculture, Giza, Egypt.

Methods

Cultivation of *Pleurotus florida* (Figure 1)

Pleurotus florida (MLCC No. 14 STCPL-Hong Kong) is cultivated according to the procedure described by Ali et al. (2013). The process of spawning involved inoculating the substrate that had been ready for mushroom growing with the spawn as follows: The rice straws were cut into 20–30 cm lengths, submerged in water three times as heavy as the straw, and allowed to soak for 24 hours before being air dried to guarantee that the water soaked into the straws thoroughly. The rice straws were soaked and then sealed in sterile plastic bags. After being sterilized for 15 minutes at 121°C, the bags were allowed to cool for 24 hours at room temperature. 50 g of the *Pleurotus florida* spawn were put into each bag and sealed once it had been prepared and refrigerated. The inoculated rice straw was incubated for at least 30 days at 25°C with light needs of 1000–1500 (2000 lux), until the fruiting body developed.

Pretreatment of LDPE bags

The low-density polyethylene bags were exposed to sunlight for 10, 20, and 40 days during the summer (15 July 2023 to 25 August2023). There are eleven hours of sunlight during this season. After each period of exposure, the plastic bags were submitted for Scanning electron microscopy (SEM). The samples were then post-fixed for one hour in 1% osmium tetroxide in cacodylate buffer after being cleaned three times with the same buffer. After several washes with distilled water, the samples were subsequently dehydrated in a graded ethanol series, 1:1 ethanol: hexamethyl disilazane and 100% hexamethyl disilazane and dried overnight in air. Dried samples were then mounted on stubs using carbon tape, and the sample was coated with gold and analyzed under a high-resolution scanning electron microscope (Quanta FEG 250, FEI, USA) at the Desert Research Centre, Cairo, Egypt.

Preparation of Culture Medium

The preparation of PDA medium requires 50 g of peeled potatoes. In 100 milliliters of water, mash the potatoes and bring them to a boil. Potato extract is obtained in a beaker by filtering the mixture through cheesecloth. After adding 5 g of dextrose, 150 mL of water is added to bring the solution's volume to 250 mL after measuring, the pH is corrected to 6, and 5 g of agar are added. A water bath is used to heat the mixture (Ricker and Riker, 1936). Boiling the mixture until the culture turns transparent is the final step. A 10-minute autoclave is then performed on the culture media at a pressure of 15 lb./inch^2. The media plate preparation process involves bringing the medium into the pre-infected laminar flow chamber after autoclaving. A portion of mushroom tissue was used as an inoculation within the laminar flow chamber after the pure culture was sterilized cooled, and PDA media were placed into sterile Petri dishes. After seven days at 25°C, the whole surface of the media in the Petri dish is covered in fungal growth (Figure 2).

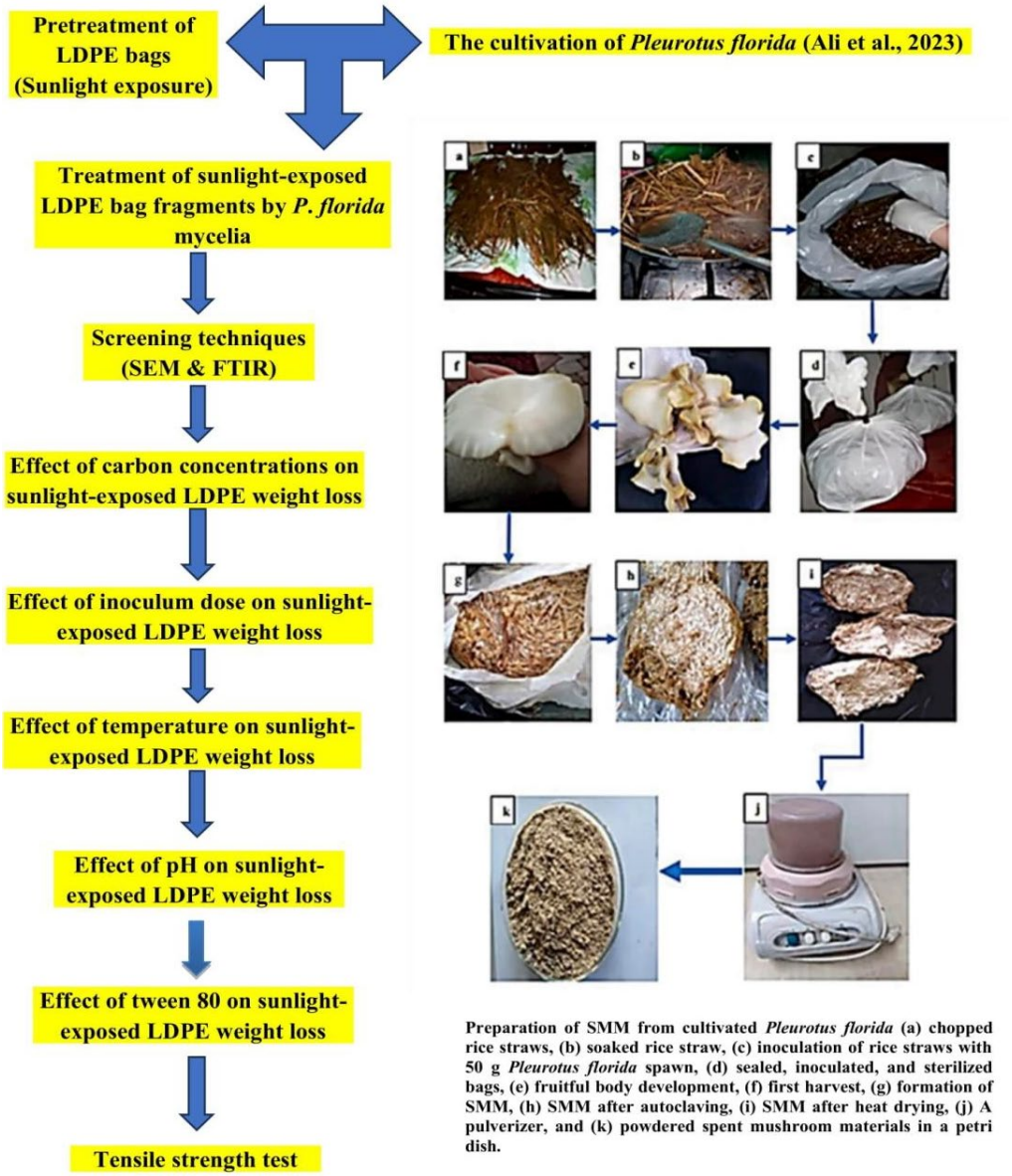

Figure 1. Insight into some of the factors that enhance the weight loss of polyethylene sheets by the cultivated *P. florida.*

To create the *P. florida* mycelia suspension, the mycelium discs were punched out using a cork borer with a 5 mm diameter. The *P. florida* mycelia suspension was made according to Ibrahim et al. (2011).

Treatment of sunlight-exposed LDPE bag fragments by *P. florida* mycelia

Dox's media were prepared in the same way as previously mentioned by Raper and Thom (1949). Potassium dihydrogen phosphate (1 g/L), magnesium sulphate (0.5 g/L), potassium chloride (0.5 g/L), sodium nitrate (3 g/L), and ferrous sulphate (0.01 g/L) are the ingredients. The LDPE bags were exposed to sunlight for varying lengths of time, ranging from ten to forty days, and were then cut into fragments measuring three centimeters by one centimeter. Three grams of the LDPE fragments were aseptically transferred to conical flasks containing fifty milliliters of Dox's broth medium, to which two milliliters of *P. florida* mycelia suspension was added separately. An experimental control was provided with LDPE plastic bags that had not been exposed to sunlight. Aseptic conditions were maintained for 10, 20, 40, and 80 days at 25°C in the flasks (Figure 3a,b). The following fragments were examined by Scan Electron microscopy and FTIR analysis. Screening techniques to study *P. florida* sunlight-exposed LDPE degradation:

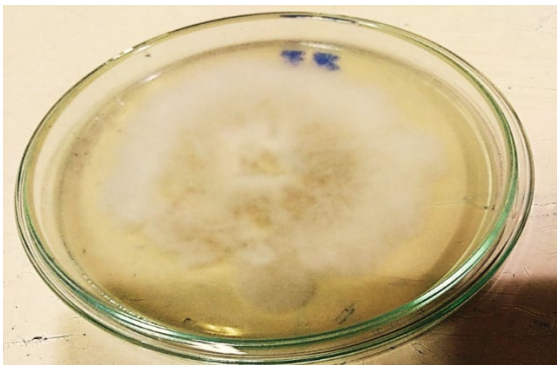

Figure 2. Potato dextrose agar Petri dishes is incubated at 25°C to grow *P. florida* hyphae.

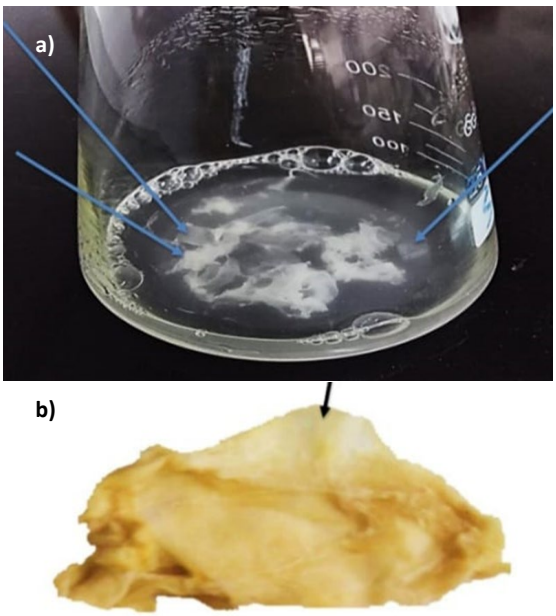

Figure 3. Treatment of LDPE fragments by two mL of *P. florida* suspension. (a) the arrows show the LDPE fragments observed after the *P. florida* incubation. (b)the arrow shows the tip of the LDPE fragment which was colonized by *P. florida* mycelia.

- Visualization is a preliminary step. Morphological observation of plastics visually involving microbial attack on the plastic surface, biofilm formation or hyphae penetration formation
- Scanning electron microscopy (SEM) was used to get a clear picture by visual observations. Sample preparation for SEM followed the protocol of Bertolacci et al. (2022) in which, samples were fixed for 2 h in 2% glutaraldehyde in 0.1 M cacodylate buffer with a pH of 7.4. The samples were then post-fixed for one hour in 1% osmium tetroxide in cacodylate buffer after being cleaned three times with the same buffer. After washing several washes with distilled water, the samples were subsequently dehydrated in a graded ethanol series, 1:1 ethanol: hexamethyl disilazane and 100% hexamethyl disilazane and dried overnight in air. Dried samples were then mounted on stubs using carbon tape, and the sample was coated with gold and analyzed under a high-resolution scanning electron microscope (Quanta FEG 250, FEl, USA) at the Desert Research Centre, Cairo, Egypt.
- FTIR Analysis or FTIR Spectroscopy can be used for observing chemical changes in the structure of LDPE. The control and treatment were analyzed using Fourier transform infrared spectroscopy. At the Central Lab, Faculty of Science, Helwan University, Cairo, Egypt, the analysis was carried out using Perkin-Elmer Spectrum version 10.5.4.
- Weight loss measures can be made to evaluate the degradation percentage. The weight of the LDPE fragment will be taken before and after inoculating with the *P. florida*. The equation (1) can calculate the loss of weight (Deepika and Madhuri, 2015). To ensure precise weight measurement of the remaining polyethylene, the fungal biofilm was removed from the polyethylene surface by using 2% sodium dodecyl sulphate (SDS) for four hours and then washing it with distilled water.

$$\text{Weight loss}\% = \frac{\text{Initial weight} - \text{Final weight} \times 100}{\text{Initial weight}} \quad \text{eq. 1}$$

Factors influencing sunlight-exposed LDPE weight loss by *P. florida*

Effect of carbon concentrations on sunlight-exposed LDPE weight loss

After preparing and filling 250 mL flasks with 50 mL of liquid Dox´s with varying sucrose concentrations (zero, 5, 10, 15, 20, 25, and 30 g/L), the mixture was inoculated with 2 mL of *P. florida* suspension and 40 days of sunlight-exposed LDPE fragment. Then cultured at 25°C for 80 days, the weight loss in (LDPE) fragment percentage determined the optimal carbon concentration to use.

Effect of inoculum dose on sunlight-exposed LDPE weight loss

Sterilized sunlight-exposed (LDPE) fragments (40 days) were added to various inoculum doses of *P. florida* (2 mL, 4 mL, 6 mL, 8 mL, and 10 mL) in 250 mL containing 50 ml (Dox´s). The mixture was then kept at 25°C for 80 days. Weight loss in (LDPE) fragments as a percentage was computed following incubation.

Effect of temperature on sunlight-exposed LDPE weight loss

After sterilizing the Dox's media, 50 mL was put into conical flasks that held 250 mL. The flasks were incubated at 20°C, 30°C, 40°C, 50°C, and 60°C for 80 days following inoculation with 10 milliliters of fungal suspension and three grammes of LDPE. Following the incubation period, the weight loss of the LDPE pieces was computed .

Effect of pH on sunlight-exposed LDPE weight loss

To 250 mL conical flasks, 50 mL of sterilized Dox's media with varying pH values of 3, 5, 7, 9, and 11 were added. Following the inoculation of 10 mL fungal suspension and 3 g of LDPE, the flasks were incubated for 80 days at 30°C. The weight loss of LDPE fragments was then calculated.

Effect of Tween 80 on sunlight-exposed LDPE weight loss

In one set of conical flasks, 0.1, 0.2, 0.3, 0.4, and 0.5 mL of Tween 80 was used as an additive. No additives were introduced to the other set of conical flasks. After being added to the 50 mL Dox´s broth media, both the fungal suspension and LDPE fragments were left to develop for eighty days. The weight loss in LDPE fragments was then measured.

Tensile strength test of sunlight-exposed LDPE

As previously mentioned by Tribedi et al. (2012), a tensiometer was used to test the tensile strength of these fragments after studying the effect of carbon concentrations, inoculum doses, temperature, pH, and Tween 80 additive.

Statistical analysis

The research's data were displayed as means ± SD. Each experiment was conducted in triplicate.

RESULTS AND DISCUSSION

Pretreatment of sunlight-exposed LDPE bag

The LDPE fragments inoculated with *P. florida* and exposed to sunlight showed altered surfaces when compared to LDPE fragments not exposed to sunlight, as shown in Figure 4a-d and Figure 5. In contrast to the fragments exposed to 20 and 40 days (Figure 4,d), which showed some pits on the fragment surfaces, the LDPE fragment exposed to zero and 10 days of sunlight appeared to have a smooth surface with no pits or particles attached to the surface (Figure 4a,b). The LDPE segment that received the *P. florida* inoculation for 10, 20, 40, and 80 days after being exposed to sunlight for 10 and 20 days demonstrated

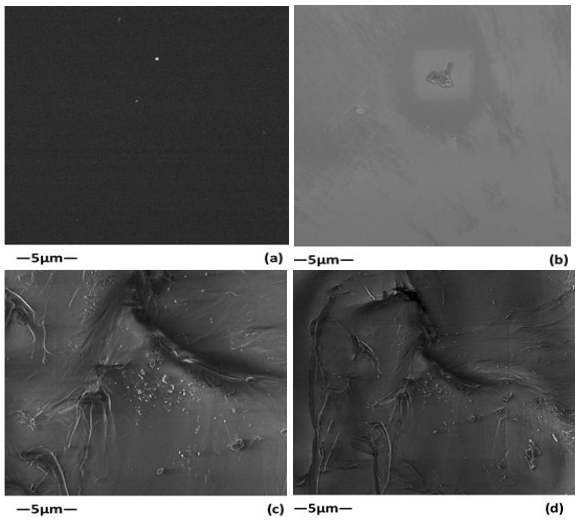

Figure 4. Scanning electron micrograph of LDPE, (a)before sunlight exposure and (b, c, and d) after 10 d, 20 d, and 40 d of exposure to sunlight. The magnification is 2000x.

the establishment of a fungal colony. Scanning electron microscopy revealed that the LDPE fragments that were colonized by fungal growth had changed from being smooth to brittle. These may be caused by photooxidation, which speeds up the polymer's biodegradation and creates a lot of surface area. The LDPE surface's well-resolved worn-out pressure-developed patches and fungal hyphae penetration may result from biofilm formation, which shows the fragment's occupant microorganisms' high adhesion skills. According to Garima et al. (2011), several studies have documented *Aspergillus niger*'s effective biofilm growth on polyethylene surfaces, demonstrating how surface damage aids in the breakdown of thermally oxidized polyethylene. Scanning electron microscopy revealed the structural changes in the form of pits and erosions due to *Aspergillus niger* adhered to LDPE and caused surface damage. In agreement with the present results, Buddolla et al. (2014) indicated that when polyolefins are exposed to gamma radiation, photo-oxidation occurs, increasing the hydrophilicity of the resulting films and allowing them to colonize and start the breakdown process by producing enzymes, especially laccase enzymes, which are known to break down wood, plastic, and paint, including jet fuel.

Treatment of sunlight-exposed LDPE bag fragments by *P. florida* mycelia

The FTIR analysis of the LDPE fragment, as shown in detail in Figure 6a, revealed multiple peaks that indicate the fragment's complex nature. The LDPE fragment under control, which was not exposed to sunlight or fungi inoculation, display multiple peaks.

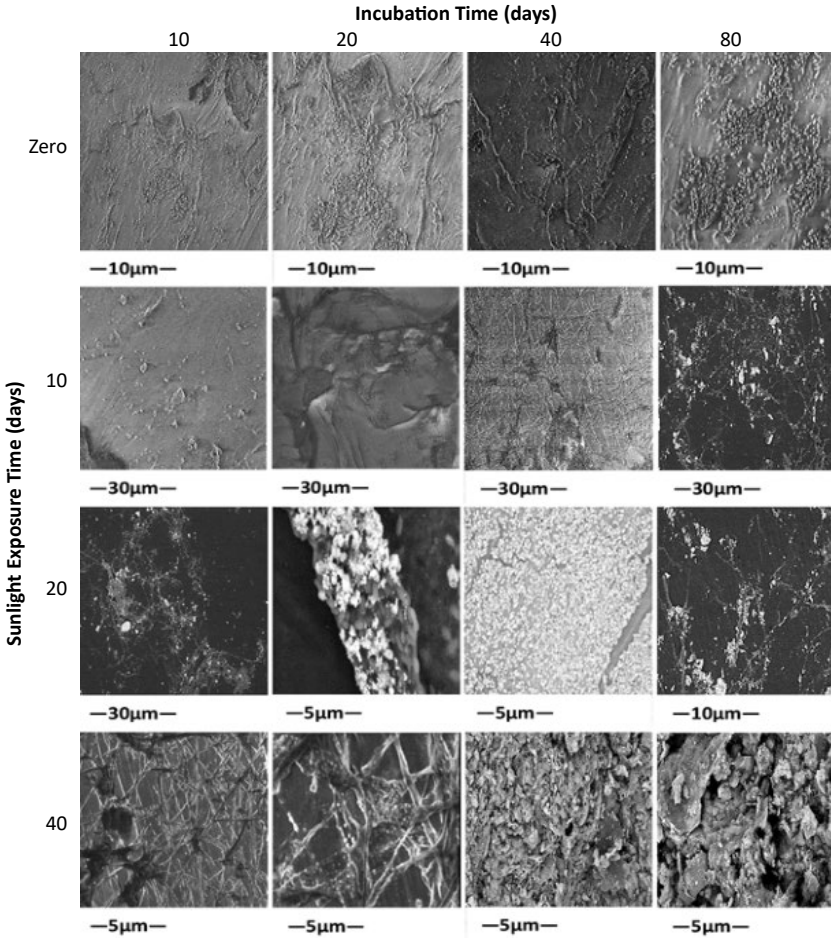

Figure 5. Scanning electron microscopy of LDPE exposed to sunlight for 0–40 d and incubated with *P. florida* for 10, 20, 40 or 80 d. The magnification is 2000x.

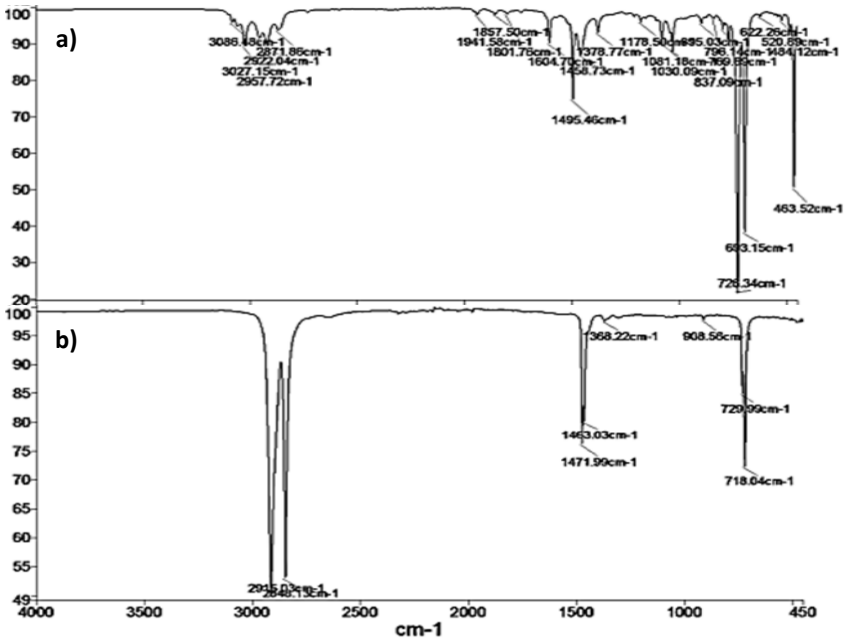

Figure 6. FTIR analysis, LDPE bag fragment, (a) LDPE bag exposed to sunlight for 40 days (b) and inoculated with *P. florida* for 80 days.

These included 3086.46 cm^{-1}, which was associated with the stretching vibration of aromatics; 2871.86 cm^{-1}, 2957.72 cm^{-1}, and 2922.04 cm^{-1}, which were assigned to the C-H stretching vibration from alkanes; 3027.15 cm^{-1}, which was associated with the stretching vibration from alkenes; and 1941.58 cm^{-1}, which was assigned to the X=C=Y the allenes, ketenes, isocyanates, and isothiocyanates, Acid chloride, 1604.70 cm^{-1}, alkenes, 1458.73 cm^{-1}, 1495.46 cm^{-1}, 1378.77 cm^{-1}, nitro (R-NO2), 1178.50 cm^{-1}, and 1030.09 cm^{-1}, and alcohols, ethers, esters, carboxylic acids, and anhydrides, 796.14 cm-1, 769.69 cm^{-1}, 837.09 cm^{-1}, 622.26 cm^{-1}, 520.89 cm^{-1}, 484.12 cm^{-1}, 463.52 cm^{-1}, 693.15 cm^{-1}, and 726.34 cm^{-1}, were assigned to the C-O. The resulting materials underwent drastic changes after LDPE fragments were inoculated with *P. florida* (Figure 6b). 2915.03 cm^{-1} was assigned to the alkanes' C-H stretching vibration, 2848.13 cm^{-1} was assigned to the aldehyde, 1471.99 cm^{-1}, 1463.03 cm^{-1}, and 1368.22 cm^{-1} was assigned to the N=O, the nitro (R-NO2), and 908.56 cm-1, 729.99 cm^{-1}, and 718.04 cm^{-1} was assigned to the alkanes' out-of-plane bend.

Also observed that FTIR spectra showed a notable shift in the group frequencies of LDPE in terms of wave number (cm^{-1}) both in the presence and when compared to non-sunlight-exposed LDPE as a control. When the 40-day sunlight exposure fragment treated by fungi was compared to LDPE that was free of fungi and sunlight, several peak shifts were observed, indicating alterations in the macromolecular fragments of the LDPE and the induction of bioactive hydrolysis in the LDPE fragment. The FT-IR results of *P. florida*-treated low-density polyethylene were evident that depolymerization had occurred because peaks at 3086.46, 2957.72, 3027.15, 1857.50, 1941.58, 1801.76, 1604.70, 1178.50, 1081.18, 1895.03, 837.09, 622.26, 520.89, 484.12, 463.52, and 693.15 cm^{-1} disappeared. In addition, a 40-day segment of fungal-treated sunlight exposure showed alterations in the peaks of the infrared spectra between 2871.86, 2922.04, 1458.73, 1495.46, 1378.77, 1030.09, 796.14, 769.69, and 726.34 cm^{-1} compared to control.

In parallel to the current results Luz et al. (2013) have also demonstrated that *P. ostreatus* has mineralized the substrate including physical changes on the surface of green polyethylene and a decrease in dry mass. The carbonyl groups in the gamma-irradiated LDPE and PP films appeared between 200 kGy and 1000 kGy, whereas the polypropene films were slightly different from the gamma-irradiated films and between 60 kGy and 100 kGy, respectively. When compared to the unirradiated control film, the irradiated (1000 kGy) film had many peaks, which are indicative of the addition of oxygen and photooxidation of the film. Also, the development and disappearance of C-H and carbonyl peaks in the polyethylene samples were linked to biodegradation concurrently with the research conducted by Asensio et al. (2009). Additionally, Muangchinda and Pinyakong (2024) reported that they investigated the biodegradation of both untreated and pretreated low density polyethylene films and found that UV pretreatment greatly accelerates degradation, resulting in weight losses of 2.22–5.17% after 120 days. The weight loss from untreated LDPE was only 1.32–2.80%, whereas the weight loss from heat and solar treatments was 1.42–3.22% and 1.67–4.56%, respectively. The significance of UV pretreatment in promoting plastic biodegradation is shown by these results.

Effect of carbon concentrations on sunlight-exposed LDPE weight loss

Figure 7 shows the effects of carbon concentrations on weight loss of LDPE fragments inoculated with *P. florida* for 80 days, followed by 40 days in the sun. According to these findings, the percentage of weight loss in LDPE fragments rose as the carbon concentration grew and eventually reached 2.5% at 30 g/L. When there was no carbon present, the LDPE fragment showed a 0.8% weight decrease. It was discovered that at 0% carbon content, LDPE fragments lost 0.8% of their weight. The capacity of *P. florida* mycelia to proliferate and use LDPE fragments as a carbon source may be the cause of these results. Parallel to Bertolacci et al. (2022) discovery, those mycelia can serve as the only carbon source for growth on LDPE/OA substrates. Also, in agreement with the present result, Dsouza et al. (2021) found the consortium of *Aspergillus* species can use low-density polyethylene as a carbon source.

Effect of inoculum dose on sunlight-exposed LDPE weight loss

The proportion of weight loss increased gradually from 2 mL to the 10 mL inoculum dose, as seen in Figure 8. The weight loss of LDPE fragments exposed to sunlight for 40 days and inoculated with *P. florida* for 80 days rose when the inoculum dose was raised, reaching 2.8% with 10 ml as opposed to 0.9% with 2 mL. It was correlated with the inoculum dose and LDPE weight loss, with a higher inoculum dose causing greater weight loss of LDPE. Additionally, it might also

be because *P. florida* mycelia can alter the weight of LDPE pieces at both high and low inoculum concentrations.

Effect of temperature on sunlight-exposed LDPE weight loss

The results in Figure 9 indicated that the temperature could enhance the weight loss of LDPE fragments. The highest LDPE weight loss (3%) was obtained at 30°C after 80 days compared with 40°C, 50°C, and 60°C, the weight loss of LDPE decreased to 2, 1.5, and 1.3, respectively. Therefore, the weight loss of LDPE decreased as the temperature rose. Similarly, the softening temperature of the polymer has a major impact on enzymatic degradability. As the temperature rises, potential enzymatic degradability falls.

Effect of pH on sunlight-exposed LDPE weight loss

The impact of pH on weight loss of LDPE is shown in Figure 10. The highest LDPE weight loss (3.2%) was obtained at pH 5 after 80 days, compared with 7, 9, and 11; the weight loss of LDPE decreased to 2, 1.5, and 1.3, respectively. pH may change the acidic or basic conditions of enzymatic degradation.

Effect of Tween 80 on sunlight-exposed LDPE weight loss

The findings that were displayed in Figure 11 show that the Tween 80 additive harmed the weight loss of LDPE fragments in a tested range from 0.1 to 0.5 mL compared with the Tween 80 additives. Tween 80's impact on *P. florida* biodegradation of LDPE was studied, and the results indicated that Tween 80 could enhance the degradation of LDPE fragments observably at low concentrations. In line with the current findings, Zhou et al. (2007) found that a high concentration of Tween 80 inhibits the growth of fungi and the breakdown of BDE-209. In contrast to these results, Xiangning et al. (2023) mentioned that the addition of Tween-80 increased the temperature in the composting formation and could effectively promote the degradation of lignocellulose and reduce phytotoxicity.

Tensile strength test of sunlight-exposed LDPE

The findings that were displayed in Figure 12 show that the tensile strength of the LDPE fragments, which were affected by *P. florida* inoculation, and it was found that the tensile strength was reduced significantly for the LDPE fragments that were treated with *P. florida*.

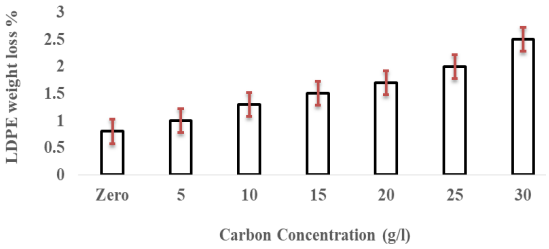

Figure 7. Effect of carbon concentration on LDPE weight loss (±SD).

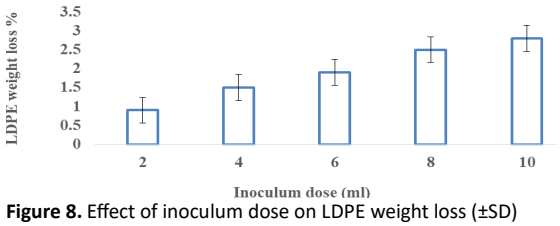

Figure 8. Effect of inoculum dose on LDPE weight loss (±SD)

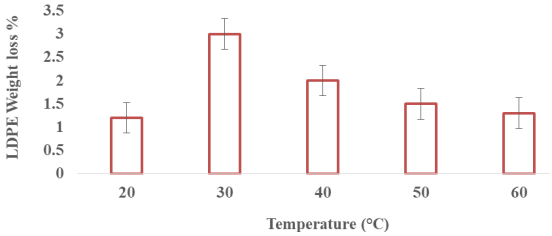

Figure 9. Effect of temperature on sunlight-exposed LDPE weight loss (±SD)

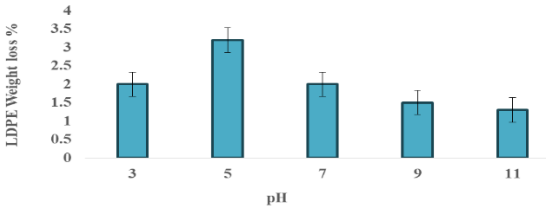

Figure 10. Effect of pH on sunlight-exposed LDPE weight loss (±SD).

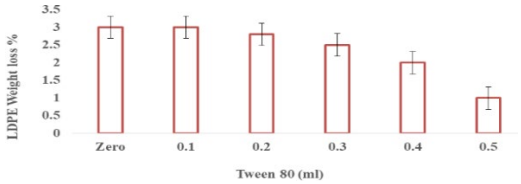

Figure 11. Effect of Tween 80 on sunlight-exposed LDPE weight loss (±SD).

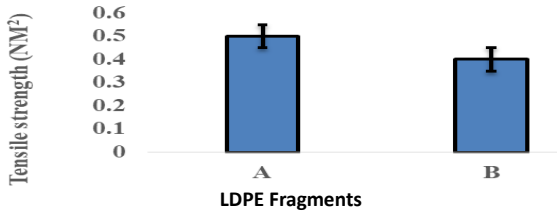

Figure 12. Tensile Strength of LDPE Fragments (±SD). Untreated LDPE fragment (A)Treated and sun-light exposed LDPE fragment by *P. florida* mycelia (B).

The tensile strength of the LDPE fragment was 0.5 NM^2 in comparison with the *P. florida* colonized LDPE fragment was 0.4 NM^2. It has also examined the tensile strength of the LDPE fragments, and it was found that the tensile strength of LDPE fragments decreased with LDPE treatment. In agreement with the present results, Tribedi and Sil (2013) found that the tensile strength was reduced significantly for the LDPE film that was treated with *Pseudomonas sp*. AKS2. *Pleurotus florida* is a very low-cost manufacturer that is already based on rice straw waste, making it easier to use it in the biodegradation of LDPE fragments exposed to sunlight. Numerous research has examined the utilization of microorganisms in the biodegradation of LDPE throughout the years. Although several studies have employed bacterial cultures in the biodegradation of LDPE in natural environments, minimal work has been carried out using fungal species in controlled environments. Also, Olga et al. (2021) studied tensile properties of Low-density polyethylene (LDPE) films and proved that the tensile strength is strongly correlated with the degree of Low-density polyethylene films crystallinity.

CONCLUSIONS

The current study demonstrates degradation of LDPE fragments by the cultivated *P. florida* mycelia requires prior sunlight exposure to increase the rate of breakdown. SEM and FTIR analyses have continuously shown that these pretreatment techniques produce favorable results. Additionally, as the inoculum dose and carbon concentrations grew, the LDPE fragment's weight loss rate increased as well. Discover if *P. florida* can grow and use LDPE fragments as a source of carbon. While, as temperature, pH, Tween 80 increased, the LDPE weight loss decreased. Also, the tensile strength of LDPE fragments decreased with *P. florida* treatment.

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AUTHORS' CONTRIBUTIONS

Conceptualization, S.A.A.; methodology, S.A.A.; formal analysis, S.A.A.; investigation, S.A.A.; data curation, S.A.A.; writing—original draft preparation, S.A.A.; writing—review and editing and supervision, S.A.A. I agreed to the published version of the manuscript.

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COMPETING INTERESTS

The author declares no competing interests.

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