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A Review On Biodegradation Of Agro-Waste By Fungi Fermentative And Edible Food Fungi (Pleurotus Ostreatus Mushrooms)

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ABSTRACT:

There are many uses by agriculture wastes, some of the Agro- wastes are husks, vegetables and fruits peels, maize or corn stalks and cobs, soybean husk, grass clippings and some other crop residues. Mostly fungi is used in biodegradation of agro wastes but it is cost effective to convert these crop wastes into useful products. Fermentative and edible food fungi is mostly used in daily life to gain essential nutrients, this review mostly focus on **Pleurotus ostreatus** commonly called as oyster mushrooms.It is also known as saprophytic basidiomycetes fungus these mushrooms are mostly grown in dead and decaying plants and biomass.

INTRODUCTION :

Among all microorganisms fungi play an important role in biodegradation process because fungi have an extracellular enzymes, these enzymes can degrade large polymers like pectin, lignin, cellulose, starch, and hemicellulose are seen in agricultural residues.Pleurotus ostreatus is a mushroom which is mostly used for nutritional purpose. These type of mushrooms largely grown over all world. Oyster mushrooms are oyster in shape, it is gray-white colour it is 5 to 20cm diameter.

mushrooms belongsto the fungi family mostly **filamentousfungi** and **basidiomycetesgroup**, these are capable of producing the extracellular enzymes and breakdown of large organic materials which are existing in agriculture wastes. Some of the basidiomycetes examples are Pleurotus, Ganoderma, Lentinula, Agaricus. Decomposition, enzymatic breakdown, bioconversion to essential products and Eco- friendly waste management are all the role of biodegradation process. There are many nutritional composition in Pleurotus mushrooms which are very important to human health, such as carbohydrates(50 to 60%), Fiber (8 to 10%), protein (20 to 30%) fat (4 to 6%), and there are some other nutrients are potassium, calcium, B complex, D2, vitamins, iron. Pleurotus Mushrooms are alsohaving beta glucans which is very useful in improving in immune power

Mushrooms are saprophytic decomposers, it uses straw, stalks, sawdust, dead plants as source of nutrient. Mushrooms mycelia are having laccase, ligninolytic, lignin peroxidase (LIP) and ligninolytic enzymes, these enzymes degrade hemicellulose and cellulose are important components of agro waste.

2. Types of agro-waste and their suitability for fungal bioconversion

Common substrates: paddy/wheat straw, sugarcane bagasse, corn cobs, soybean residue, sawdust, rice husk, tea waste, banana pseudostem, and other crop residues. Substrate suitability depends on lignin/cellulose/hemicellulose ratios, particle size, moisture holding capacity and nutrient content; many studies report improved mushroom biological efficiency when substrates are supplemented (e.g., with bran, manure, or legume residues). Pretreatments (physical chopping, steam, alkali, or biological preconditioning) can increase digestibility and fruiting yield. Examples of successful substrates and combinations for *P. ostreatus* cultivation are reported widely. Microbiology Journal+1

3. Fungal mechanisms of lignocellulose biodegradation

White-rot fungi (including many *Pleurotus* spp.) mineralize lignin using extracellular oxidative enzymes — **laccase**, **manganese peroxidase (MnP)** and, in some species, **lignin peroxidase (LiP)** — producing radical-mediated breakdown of phenolic and non-phenolic lignin structures. Simultaneously, a battery of **cellulases** (endoglucanase, exoglucanase, β-glucosidase) and **hemicellulases** (xylanases, mannanases) depolymerize polysaccharides. The interplay of selective delignification and polysaccharide hydrolysis increases substrate accessibility and nutritive value for both the fungus and downstream applications (e.g., animal feed). Regulation of enzyme expression depends on substrate composition, growth stage, pH, temperature, and inducers. PMC+1

4. Fermentative strategies: Solid-State vs Submerged Fermentation

- **Solid-State Fermentation (SSF):** Mimics natural fungal growth on solid substrates with low free water; widely used for mushroom cultivation and for producing lignocellulolytic enzymes directly on agro-waste. SSF is energy-efficient, has low wastewater generation, and often yields enzyme mixtures well suited to lignin/cellulose breakdown. *P. ostreatus* performs effectively under SSF for both fruiting body production and enzyme harvest. Preprints+1
- **Submerged Fermentation (SmF):** Used for targeted enzyme production in liquid cultures; allows easier process control and downstream enzyme recovery but requires substrate hydrolysates or soluble inducers and typically higher energy/input. SmF can complement SSF when producing concentrated enzyme preparations for industrial use. Taylor & Francis Online

5. *Pleurotus ostreatus* as an edible and fermentative agent

P. ostreatus is prized for its nutritional value (proteins, fibers, vitamins, bioactive compounds), short cultivation cycle and broad substrate range. Cultivation on agro-waste not only yields marketable mushrooms but also converts low-value residues into a protein-rich food while simultaneously degrading lignin and increasing the digestibility of residual cellulose/hemicellulose. Many recent trials report good biological efficiency and yield when *P. ostreatus* is grown on sugarcane bagasse, paddy straw, sawdust mixtures, tea waste blends and supplemented residues. Microbiology Journal+1

6. Spent Mushroom Substrate (SMS): opportunities and management

After harvesting, SMS remains rich in partially degraded lignocellulose, fungal biomass and enzymes. SMS can be: (i) used as compost/soil amendment or biofertilizer; (ii) processed into animal feed after nutritional analysis or further fungal/enzymatic treatment; (iii) a feedstock for production of enzymes, biochar, or platform chemicals (via further microbial or thermochemical processing); and (iv) incorporated into biomaterials (mycelium-based composites). Proper handling and maturation steps are required to stabilize SMS and avoid phytotoxicity. PMC+1

7. Industrial and environmental applications

- **Enzyme production:** *P. ostreatus* secretomes are a source of laccases and other enzymes for pulp/paper, dye decolorization, and bioremediation.
- **Bioremediation:** Degradation of agricultural chemical residues and some xenobiotics through ligninolytic activity.
- **Animal feed:** Biological upgrading (increased protein, decreased anti-nutritional factors) of crop residues for ruminant feed.
- **Circular economy:** Integration of mushroom cultivation into agro-industries reduces residue disposal costs and creates value streams (food, SMS for compost). Taylor & Francis Online+1

8. Process parameters and optimization strategies

Key factors affecting degradation and yield: substrate particle size and porosity, moisture content (typical SSF: 55–65%), C:N ratio (often adjusted with supplements), spawn rate and quality, incubation temperature and aeration (to control CO_2 and heat), and pasteurization/sterilization steps to manage contaminants. Biological preconditioning (short fungal preincubation) or co-cultivation with enzyme-producing strains can improve delignification and mushroom yields. Process standardization is needed for scale-up. PMC+1

9. Safety, quality and regulatory considerations

Edible fungi cultivated on wastes require control of contaminants (molds, mycotoxin producers), heavy metals, and pesticide residues. Substrate sourcing and testing, appropriate pre-treatment (e.g., pasteurization), hygienic cultivation, and postharvest testing (microbial load, residual agrochemical analysis) are crucial for food safety. SMS used as feed/soil amendment requires stabilization and testing for phytotoxic compounds. PMC+1

10. Challenges, knowledge gaps and future directions

- **Standardization & reproducibility:** wide heterogeneity in substrate reporting and cultivation protocols obstructs cross-study comparisons.
- **Scale-up:** controlling heat, moisture and contamination in large SSF beds is nontrivial — engineering solutions and continuous reactors merit development.
- **Mechanistic understanding:** omics (transcriptomics/proteomics/metabolomics) of *P. ostreatus* during growth on different wastes can reveal regulatory networks and enzyme induction patterns to tailor strains or processes.
- **Valorization pathways:** techno-economic and life-cycle assessments are needed to prioritize outputs (food vs enzyme vs bio-materials) and guide policy incentives.
- **Integration into circular bioeconomy:** pilot demonstrations that connect farms, agro-processors and mushroom units show promise; more real-world trials and socio-economic studies are required. PMC+1

CONCLUSION:

In biodegradation of agro waste,mushrooms are most efficient fungi which convert low-value material into nutrient rich product. In biodegradation of agro waste by fungi are having dual role in food production and management of waste. These all tools make environmental and agricultural sustainable and bioeconomy. In agro waste production of mushrooms includes eco friendly and solution to waste management treatment. Mushrooms transform agro waste like crop residues into useful and edible products. By this biodegradation process produces biofertilizers, organic manure and nutrient rich mushrooms apart from reducing pollution from agro waste.

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