Chapter 8
Effective Management of Agro–Industrial Residues as Composting in Mushroom Industry and Utilization of Spent Mushroom Substrate for Bioremediation

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ABSTRACT
Different types of edible mushrooms like Agaricus, bisporus, A. bitoriquus, Pleurotus spp., Volvariella volvacea, Lentinula edodes, Calocybe indica, Flammulina, Ganoderma lucidum etc. are cultivated in industrial scale. Majority of edible fungi secretes extracellular Ligninocellulolytic enzymes like Laccase, lignin peroxidase, manganese peroxidase, cellulase etc. for effective conversion of ligninocellulolytic substrate to composting form which led to fruiting of mushrooms. Consequently, an adequate disposal method is needed for the high quantities of spent mushroom substrate (SMS) generated in this agro-food industrial activity. On the other side, textile industry among the largest water consuming industries in the world and approximately, 10,000 different dyes and pigments are used at industrial scale. It is estimated that nearly 40% of the total dyes used in the dyeing process may find their way in wastewater. So, there is an attempt to utilize the ligninolytic enzymes rich SMS of different mushroom for efficiently biodegradation of textile wastewater & polyaromatic pollutants.

1. INTRODUCTION
Mushroom cultivation is a common practice all over the world and is a major income source in China and other developing countries which also suffer from serious pollution. Total edible species of mushrooms are approximately 2000 and total edible species under cultivation are nearly 20 at commercial

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level. World mushrooms production annually is greater than 25 million ton (Li, 2012). Total annual mushroom production in India is 1, 20, 000 tons (DMR, 2014). Annually, world production of major lignocellulolytic biomass waste is around 1088.258 million tons (FAO). Mushroom cultivation offers a highly efficient method capable of not only biodegradation and bioremediation of agro-industrial waste but also biotransformation into proteinaceous food that can sustain food security in the developing countries (Ingale & Ramteke 2010; Narain et al. 2011; Philippoussis & Diamantopoulou 2011; Kulshreshtha et al. 2010). Many basidiomycetes fungi are edible mushrooms whose industrial production generates significant amount of spent mushroom substrate (SMS) with residual high levels of lignin-degrading extracellular enzymatic activities. Annual spent mushroom substrate required to be disposed of in India is around 6,00,000 tons (Table 1). Spent mushroom substrate (SMS), has recently gained importance because of its unique physical, chemical and biological properties. Spent mushroom substrate (SMS) is a biomass waste generated from mushroom production. About 5 kg of SMS is generated for every kg of mushroom produced (Williams et al., 2001). Spent mushroom substrate (SMS) is the substrate left over after mushroom harvesting. The rapid growth in mushroom production worldwide has resulted in large quantities of SMS (about 13.6 million tons per year) (Williams et al., 2001; Uzun, 2004). These massive amounts of waste can cause environmental problems, which has led to increased research to develop technologies for treating these type of waste substrate. SMS mainly contains lignocellulosic materials, such as sawdust, wheat straw, paddy straw, wheat bran, chicken manure and cotton seed hulls, which have been decomposed and permeated by mycelium.

The composting of spent mushroom substrate yields a product that is valuable for agricultural utilization and soil reclamation. Mushroom produces don’t reuse this spent mushroom substrate (SMS), because disease incidence, nutrient depletion and growth factor depletion. SMS has rich heterogeneous microbial populations with remains of mushrooms mycelia, actinomycetes and bacteria. It has a high organic content and low concentration of essential plant nutrient contents.

Activities in mushroom industry is steadily growing, the quantity of mushroom waste (SMS) generated annually is increasing. In recent years, the mushroom industry has faced challenges in storing and disposing these waste substrates. The obvious solution is to explore new applications and development of new technologies for the management and effective utilization of SMS. In last decades, there has been considerable discussion recently about the potential of using SMS for bioremediation of environmental pollutants.

The increasing industrialization has specially put pressure on natural resources like water bodies, agricultural land and the physical area by adding unwanted chemicals in the environment. The manufacturing and use of dyes and pigments is a multibillion-dollar industry. The use of these chemicals is an integral part of almost all manufacturing processes. Dyes are synthetic chemical compounds having complex aromatic structures, which are extensively used in the textile, cosmetics, plastic, food, paper printing, colour photography and pharmaceuticals industries. Approximately 10,000 different dyes and pigments are used at industrial scale and over 0.7 million tonnes of synthetic dyes are produced annually, worldwide (see Figure 1 and Table 1).

When such wastewater effluent is discharged onto the land adjoining the agriculture crops, it causes the gradual deterioration of land quality and ultimate reduction in crop yields. Colour is the first recognised contaminant in textile wastewater and has to be removed before discharging it into receiving water body. Among various industrial effluents involved in an increase of chemical load (COD) of water systems, effluents from textile dyeing industries are the major source, resulting discharge of coloured water causing toxicities to aquatic life. The presence of a variety of dyes in the wastewater emanating from textile