



Anoxia and anaerobic respiration are involved in “spawn-burning” syndrome for edible mushroom *Pleurotus eryngii* grown at high temperatures



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ABSTRACT

“Spawn-burning” syndrome has become one of the most serious problem for edible mushroom cultivation in mushroom bags at high growth temperatures in China. The symptoms of spawn-burning are that the mushroom mycelia ceases growth, dies, and becomes contaminated with mould and bacteria. This article used *Pleurotus eryngii* as material to study the cause of spawn-burning syndrome. Spawn-burning of *P. eryngii* occurred at 34 °C, which was far lower than maximum growth temperature of 38 °C or the lethal temperature of 41 °C. Aerobic respiration increased at high growth temperature. At 34 °C, there was increased oxygen consumption by aerobic respiration and decreased dissolved oxygen content in the mushroom bags resulting in anoxia. Anaerobic respiration increased with higher anaerobic respiratory enzyme activities for alcohol dehydrogenase (ADH), pyruvate decarboxylase (PDC), and lactate dehydrogenase (LDH), increased. The anaerobic respiration metabolites of ethanol, acetaldehyde and lactate accumulated, which have an inhibitory effect on mushroom mycelia growth. In conclusion, inadequate oxygen supply in the bags to the mycelia was correlated to spawn-burning at high growth temperature. On this basis, methods to increase oxygen supply for mushroom bags will need to be developed to control spawn-burning for edible mushroom production.

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1. Introduction

Cultivation of edible mushrooms is one of the most important commercial agricultural industry in China and some other Asian countries with total yield exceeding more than twenty million tons (fresh weight) in China in 2012 (Zhang and Li, 2014). The bag cultivation technique for edible mushroom production was developed in the early 1970s in China. For this technique, lignocellulosic substrates are packed into plastic bags. More than thirty million tons of lignocellulosic agricultural waste were utilized by producing edible mushroom every year in China. The bags are then autoclaved, cooled, inoculated, incubated, and then opened for fruiting. Now, all the wood rot edible mushrooms, such as *Pleurotus ostreatus*, *Pleurotus eryngii*, *Lentinula edodes*, are planted using the bag cultivation

technique, because it can retain moisture, prevent contamination of other microorganisms, and increase yield.

A syndrome known as spawn-burning often occurs in cultivation bags which suffered from high temperature stress during spawn-running phase in summer (Biao et al., 2000; Li, 2004). The mycelia in the cultivation bags cease growing, and become yellow or brown at different extents, and become susceptible to contaminative mould or bacteria. Even the whole bags were colonized by mould or bacteria completely as the stress of high temperature lasted. The temperature of spawn-burning varied for difference species of edible mushrooms. For example, *Flammulina velutipes*, *P. eryngii* and *P. ostreatus* developed spawn-burning above 30 °C, 34 °C and 35 °C, respectively. Spawn-burning has become the most serious problem for edible mushroom cultivated with bags in summer.

It was thought that spawn-burning was caused by environmental high temperatures that directly damaged mycelia resulting in mycelial death. However, the mycelial metabolic activity increased the temperature of bags. It has been suggested that strain selec-

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