CHAPTER 13

BIOLOGY OF ARTIFICIAL LOG CULTIVATION OF *AURICULARIA* MUSHROOMS

X.C. Luo

Central China Agricultural University, Wuhan, China.

1. INTRODUCTION

Auricularia mushrooms are a kind of jelly fungi, which are widely distributed in areas of the tropics and subtropics. *Auricularia*, the Jew's ear fungus, is a traditional food in China. Its nutritive and medicinal value has long been praised as "health food" (Yang, 1988). Annual production of fresh *Auricularia* species in Asia has been estimated to be 172 thousand tons with a value of about $255 million (Chang, 1985).

Auricularia species are reported to have been grown in China two thousand years ago. China has an ancient history in *Auricularia* mushroom utilization both as food and as a medicine. In recent years, artificial log cultivation for *Auricularia* mushrooms has undergone a great development in China.

2. CLASSIFICATION AND NATURAL DISTRIBUTION

Auricularia species are basidiomycetes. Their classification is based on the morphological characters and internal structure of the fruitbodies. It is reported that there are 15-20 species worldwide. Eight species, *A. auricula*, *A. polytricha*, *A. mesenterica*, *A. delicata*, *A. fuscosucoinea*, *A. peltata*, *A. cornea*, and *A. hispida*, have been identified in China. They are distributed in the tropical and subtropical areas or regions of China but the distribution of *A. auricula* is in the temperate zone regions and this species is found adventively in tropical areas.

Nowadays in China, *Auricularia auricula* and *A. polytricha* are widely cultivated by the artificial log method using diverse agricultural wastes.

3. MATING TYPE AND MONOKARYOTIC FRUITBODY

Both *A. auricula* and *A. polytricha* exhibit bipolar heterothallism. Their mating type is controlled by one factor (Luo & Chen, 1989). Monokaryotic fruitbodies can be produced in the life cycle of *A. auricula*. However, this monokaryotic fruitbody is not ideal in terms of quality and quantity. Monokaryotic fruitbodies have not been observed in the life cycle of *A. polytricha*.

4. CONDITIONS FOR GROWTH AND DEVELOPMENT

4.1. Nutritive Conditions

The range of carbon source utilization for mycelial growth is wide. Monosaccharides, disaccharides and polysaccharides can be used as carbon sources. Monosaccharides (such as fructose, glucose, etc.), or maltose among the disaccharides, are the most suitable carbon sources for *A. auricula*.

Organic nitrogen sources are obviously superior to mineral nitrogen and only nitro-nitrogen used as nitrogen source is unsuitable for mycelial growth of *A. auricula*. Corn steep liquor, peptone and yeast extract is the most preferable nitrogen source.

The most suitable carbon-nitrogen ratio should be 35:1 and the amount of mycelium will decrease under conditions where the carbon-nitrogen ratio is higher or lower.

Different mineral elements and vitamins produce different effects on mycelial growth within a certain concentration range. Calcium and vitamin B_1 (0.5-1 ppm) facilitate mycelial growth of *A. auricula*. Cellobiose and refined peptone are the most suitable carbon and nitrogen sources, and vitamin B_6 has an obvious stimulatory effect on basidiospore germination.

4.2. Physical Conditions

Auricularia mushrooms are moderate temperature fungi. The temperature range for mycelial growth is 6-36°C with the most suitable temperature 22-30°C. Below 5°C and above 38°C, mycelial growth is restrained, but it has a strong tolerance to short-term cold and heat. The evolution and development of the fruitbody occurs between 15-27°C, but the best range is 20-24°C. The temperature range for basidiospore germination is 22-32°C.

At low temperatures, growth and development of *Auricularia* mushrooms is slow but the mycelium is strong and the fruitbody blacker and thicker, whereas at higher temperatures, the mycelium and fruitbody are weaker and thinner. At higher temperatures and air humidity, wood ear softening will appear.

Water plays an important role in the growth and development of *Auricularia* mushrooms. A water content of 60-65% in artificial logs is suitable for mycelial growth. Less water will affect the capacity of the mycelium to absorb and utilize nutritional substances, and more water will lead to a lack of oxygen and restrained mycelial growth. Air humidity of 90-95% is suitable for the formation and appearance of fruitbodies. Below 80% humidity, the fruitbody dries out and becomes shrivelled, and its growth and development stop.

Light plays an important role in fruitbody formation and the mushroom requires not only a quantity of diffused light but certain directly radiated light. The fruitbody thus formed is black and strong. A light intensity of 500 lux is preferable for fruitbody formation. Fruitbody formation does not occur in the dark. Mycelial growth is normal under dark conditions but diffused light has a facilitating action. *Auricularia* mushrooms are aerobic fungi. Air which is not fresh, or a lack of oxygen, will have an adverse effect on mycelial growth and fruitbody formation. Stagnant air causes

fruitbody deformities and soft rot, and the mushroom takes on the appearance of a toadstool.

4.3. pH

Vigorous mycelial growth occurs in substances where the pH ranges between 5.5 and 6.5. The growth rate of the mycelium markedly decreases at pH values below 5 and above 7.

5. CELLULASE AND LIGNINASE ACTIVITIES AND DEGRADATION OF THE CULTIVATION SUBSTRATE

Cellulose and lignin in the cultivation substrates are respectively lysed by extracellular enzymes and polyphenoloxidase produced by mycelia of *Auricularia* mushrooms.

Cellulases (C_1, C_x and β-glucosidase) and hemicellulase activities are closely related to the degradation rate of cultivation substrates and yields of fruitbodies. It is reported that a strain with the highest extracellular enzyme activity has the highest level of ligninase activity during the period of mycelial growth. However, the activity of ligninase is reduced during the period by primordia evolution. During this period, cellulase activity is higher than that of acid proteinase. By reason of the lignin in the substrates being degraded quickly, the amount of soluble carbohydrates produced not only supply the energy for mycelial growth but raise the carbon-nitrogen ratio. This produces an environment in which the mycelium reverts rapidly to generative growth. The increased cellulase activity during the generative period facilitates the formation of fruitbodies.

6. THE FIVE STAGES OF FRUITBODY DEVELOPMENT

The development process for fruitbodies in *Auricularia* mushrooms is divided into five stages, i.e. rice grain, coral, wood ear appearance, wood ear unfolding and maturation stage. The duration of each stage is 1.5, 1.5, 2, 1.5, 2 days respectively at 24°C and 95% air humidity.

7. ARTIFICIAL LOG CULTIVATION OF AURICULARIA MUSHROOMS

At present, artificial log cultivation of *Auricularia* mushrooms is very popular in China. Cotton seed shells, sawdusts, sugarcane, rice straw and corn residues are major cultivation materials. One of the major materials (90%) is mixed with 8% wheat and wheat bran, and 1% each of gypsum and sugar, and water is added. A water content of 60-65% is preferable for the mixed cultivation materials used for the artificial log. Rice straw must be softened in lime water at pH10 for 3 days if it is used as the major material.

The procedure for artificial log cultivation of *Auricularia* mushrooms is: preparation of artificial log - autoclave/sterilization - inoculation - incubation - control of fruitbody formation period - harvest. In general, the biological efficiency (i.e. ratio of fresh mushroom yield by 100kg dry substances), ranges from 70-80%.

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