

摘 要

茯苓 (*Wolfiporia cocos*) 屬於食藥兼用之真菌菇類。傳統中醫用於治療小多種疾病。藥理研究證實茯苓的有效成分可對人體有抗腫瘤增、抗氧化、抑制發炎、腎臟炎、糖尿病等多種功能。若能以人工培養，則可推廣應用於醫療保健的食品市場。

本研究主要是利用液態培養，在培養基中添加不同濃度的橄欖油，找出最適培養條件，將此最適培養基擴大於發酵槽培養，探討不同通氣條件和不同培養方法，找出茯苓最適培養環境，以利菌絲體生長以及多醣體的代謝，並分析多醣的分子量分佈。

結果顯示，茯苓在搖瓶實驗的培養基中分別添加 1 至 5% 橄欖油，在 26°C，轉速 100rpm，發酵七天的過程中，其最適胞內、胞外多醣的添加濃度為 4%；而最適菌絲體的生長則為 5%。在不同通氣量部分，5 公升的攪拌式發酵槽(stirred tank fermentor)及 7 公升的氣泡塔式發酵槽(bubble column fermentor)，以後者培養較佳，可 0.39mg/ml 的胞外多醣；在不同的培養方式方面，以攪拌式發酵槽饋料培養較佳，可得 0.22mg/ml 的胞外多醣。

在茯苓多醣的分子量方面，攪拌式 1vvm、氣泡塔式 2vvm 和氣泡塔式 0.5vvm 的發酵槽中，在發酵液所形成的胞外多醣，在發酵初期由單一分子量組成，到發酵後期則變為兩種主要分子量所組成，分子量範圍是 10^3 Da 至 10^8 Da。攪拌式 0.5vvm 則是在發酵初期的兩種胞外

多醣分子量變為單一分子量，分子量範圍是 10^7 Da 至 10^6 Da。而攪拌式 2vvm 和氣泡塔式 1vvm 胞外多醣分子量由發酵開始至結束，都維持一種，分子量範圍 10^3 Da 至 10^9 Da。饋料式發酵所產生之胞外多醣分子量分佈，其中攪拌饋料式有兩種，範圍分別是 10^6 Da 至 10^7 Da，泡氣泡塔饋料式胞外多醣分子量是單一種，分子量約為 10^3 Da。從本實驗發現不同通氣量、不同培養方式也會造成不一樣的分子量分佈。氣泡塔式發酵槽再配合較大的通氣量是茯苓較佳的培養環境。

關鍵字：茯苓、多醣體、攪拌式發酵槽、氣泡塔式發酵槽、饋料培養

Abstract

Wolfiporia cocos is an edible fungi, it has long been used as traditional Chinese herb with curing incontinence, edema, sputum, palpitations and sleeplessness. Pharmacology studies have proven that its anti-tumor, anti-emetic, anti-inflammation, anti-nephritis, diabetes. The potential markets for *W.cocos* as nutraceutical and pharmaceutical products will stimulate the research for methods of its cultivation.

The results indicated that in shake flask fermentation at 26°C, 100rpm, a 5% olive oil addition in the medium is the best among different concentrations for the mycelium growth, while the 4% olive favors the exo-polysaccharide formation. In fermentor studies, the 7 liter bubble column fermentor (BCF) with 2 vvm aeration is the best for exo-polysaccharide production, and has a concentration of 0.39mg/ml in 7 days, as compared to 0.23mg/ml by 5 liter stirred tank fermentor (STF) at 2 vvm. At 1 vvm, the polysaccharide is 0.17 mg/ml and 0.21 mg/ml for BCF and STF, respectively. Lower aeration rate resulted in poor polysaccharide production which is caused by the aggregation of the mycelium which accumulated at the bottom of fermentor, and interfered the air supply.

The fermentation condition affects the molecular weight (MW) of the polysaccharides greatly. MW distribution of polysaccharides, as determined by GPC, from STF 1vvm, BCF 2vvm, and BCF 0.5vvm, were in the range of $10^3 \sim 10^8$ Da, and during the 7 days fermentation, the MW changed from one single distribution in early stage into two MW distribution in the late stage. STF 2vvm and BCF 0.5 vvm was in the range of $10^3 \sim 10^9$ Da, while the MW was unchanged throughout the cultivation period.

Key word : *Wolfiporia cocos*, polysaccharides, stirred tank fermentor, bubble column fermentor, Fed-batch fermentation