

Influence of culture substrate on the phytochemical contents of fruiting bodies and spores of 3 varieties of *Ganoderma lucidum*

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Abstract The aim of this research was to evaluate the influence of culture substrate on the phytochemical contents of fruiting bodies and spores of 3 different varieties of *Ganoderma lucidum*. Three varieties (Longzhi No.1, Hunong No.1 and Xianzhi No.1) of *G. lucidum* were cultivated in two culture substrates (wood cultivation and substitute cultivation). Substitute-cultivated *G. lucidum* mushrooms exhibited higher phytochemical contents (polysaccharides, total triterpenoids and total phenolic) in fruiting body than wood-cultivated *G. lucidum* mushrooms. On the contrary, the polysaccharide and total triterpenoid content in wood -cultivated *G. lucidum* were higher than in substitute-cultivated *G. lucidum*. The fruiting body exhibited higher phytochemical contents than spores in *G. lucidum*. The current study provides useful information on mushroom cultivation and the effective utilization of *G. lucidum* in food processing.

Introduction

Ganoderma lucidum (Lingzhi), a traditional medicinal fungus, is effective in treating hypertension, allergies, inflammation, hyperglycaemia, and cancer [1, 2]. Polysaccharides, triterpenoids and phenolic compounds are the major pharmacologically active components in *G. lucidum* and constitute the phytochemical components of *G. lucidum* [3-7]. Wild mushrooms of *G. lucidum* are very rare in nature and are not sufficient for commercial exploitation. In order to meet the increasing demands of international markets, a large number of studies relating to the artificial cultivation have been reported [8]. Wood cultivation and substitute cultivation are the most

important methods of artificial cultivation. In the present study, the effects of wood cultivation and substitute cultivation on polysaccharides, total triterpenoids and total phenolic contents in 3 varieties of *G. lucidum* (Longzhi No.1, Hunong No.1 and Xianzhi No.1) were investigated.

Materials and methods

Sample preparation

Samples of the fruiting bodies and spores of *G. lucidum* were collected from the farm of the Zhejiang Academy of Agricultural Science. The fruiting bodies were dried in a forced-draught oven at 60 °C for about 24 h upon acquisition. The samples were cleaned by brushing off soil dust from the surface and ground to fine pieces with a blender. The ground samples were sifted through a 20 mm mesh. These sifted powders were used for further analysis. The spore was dried and wall-broken for further use.

Determination of active compounds

The polysaccharide content was determined according to the method of Heleno *et al.* [9]. The total triterpenoids contents were determined according to the methods of Zhou *et al.* [10] and the total phenolic content was determined using the Folin-Ciocalteu reagent [11].

Statistical analysis

All the experiments were carried out in triplicate and data were expressed as mean \pm standard deviation. Statistical analysis was performed with ANOVA followed by Student's *t*-test. A level of $P<0.05$ was taken as statistically significant.

Table 1. Effect of culture substrate on the phytochemical contents of the fruiting body of 3 varieties of *Ganderma lucidum*

Variety	culture substrate	Polysaccharide content (mg glucose/g dry materials)	Total triterpenoids contents (mg ursolic acid/g dry materials)	Total phenolic content (mg GAE/g dry materials)
Longzhi No.1	Substitute culture	28.83 \pm 1.15 ^a	13.68 \pm 0.57 ^a	14.2 \pm 2.57 ^a
	Wood culture	24.13 \pm 1.83 ^b	15.82 \pm 1.09 ^b	16.44 \pm 4.21 ^a
Hunong No.1	Substitute culture	30.48 \pm 2.34 ^a	13.29 \pm 1.84 ^a	20.82 \pm 1.89 ^a
	Wood culture	26.56 \pm 1.69 ^a	26.13 \pm 1.72 ^b	27.76 \pm 3.66 ^b
Xianzhi No.1	Substitute culture	24.13 \pm 1.22 ^a	27.24 \pm 3.35 ^a	22.74 \pm 2.09 ^a
	Wood culture	21.18 \pm 0.98 ^b	17.73 \pm 2.86 ^b	15.05 \pm 1.96 ^b

Values are presented as mean \pm standard deviation ($N=3$). Means with different lower case letters with in a column are significantly different for the same varieties.

Results and discussion

Phytochemical content

As shown in Table 1 and Table 2, polysaccharides, total triterpenoids and total phenolic contents were determined from fruiting body and spores of 3 varieties (Longzhi No.1, Hunong No.1 and Xianzhi No.1) of *G. lucidum* that were cultivated in different culture substrates (wood cultivation and substitute cultivation). In the fruiting body of *G. lucidum*, the polysaccharide content of the different samples varied from 21.18 to 30.48 mg glucose/g dry material. It was interesting to observe that the substitute-cultivated mushrooms have higher polysaccharide contents than the wood-cultivated mushrooms in all the three varieties. Compared to wood cultivation, substitute cultivation has better distribution and availability of nutrients that allows for better absorption of nutrients, resulting in faster growth and increased polysaccharide contents. For the total triterpenoids and total phenolic contents, the results in Longzhi No.1 and Hunong No.1 were the same to the polysaccharide content. However, in substitute-cultivated Xianzhi No. 1, the total triterpenoid and phenolic contents of the fruiting body were 27.24 mg ursolic acid/g dry material and 22.74 mg GAE/g dry material, respectively. The total triterpenoid and total phenolic contents of wood-cultivated Xianzhi No.1 were reduced to 17.73 mg ursolic acid/g dry material and 15.05 mg GAE/g dry material, respectively.

In the spores of *G. lucidum*, it was interesting to note that the polysaccharide and total triterpenoids contents in wood cultivation were higher than those obtained from substitute cultivation in all the 3 tested varieties. On the contrary, the total phenolic content in substitute-cultivated *G. lucidum* was higher than that obtained from wood-cultivated *G. lucidum* in all 3 tested varieties.

Table 2. Effect of culture substrate on the phytochemical contents of the spores of 3 varieties of *Ganderma lucidum*

Variety	culture substrate	Polysaccharide content	total triterpenoids contents	Total phenolic content
		(mg glucose/g dry materials)	(mg Ursolic acid/g dry materials)	(mg GAE/g dry materials)
Longzhi No.1	Substitute culture	36.89 ±0.57 ^a	8.93 ±0.86 ^a	10.57 ± 0.53 ^a
	Wood culture	41.33 ±1.76 ^b	9.19 ±0.52 ^a	8.75 ±0.98 ^b
Hunong No.1	Substitute culture	34.77 ±1.45 ^a	10.46 ±0.37 ^a	10.14 ±0.88 ^a
	Wood culture	36.85 ±1.11 ^a	11.79 ±0. 77 ^b	6.94 ±1.05 ^b
Xianzhi No.1	Substitute culture	33.42 ±1.29 ^a	8.46 ±0.48 ^a	10.78 ±1.38 ^a
	Wood culture	39.26 ±1.54 ^b	9.86 ±0.65 ^b	7.79 ±0.89 ^b

Values are presented as mean ± standard deviation (N=3). Means with different lower case letters with in a column are significantly different for the same varieties.

Conclusions

In the present study, the influence of culture substrates on the phytochemical contents of the fruiting bodies and spores of 3 varieties of *G. lucidum*, was investigated. Three varieties (Longzhi No.1, Hunong No.1, and Xianzhi No.1) and 2 culture substrates (wood cultivation and substitute cultivation) were investigated. Substitute-cultivated mushrooms of *G. lucidum* exhibited higher phytochemical contents (polysaccharides, total triterpenoids and total phenolic content) than wood-cultivated mushrooms of *G. lucidum* in the fruiting body. On the contrary, the polysaccharide and total triterpenoid content in wood-cultivated varieties of *G. lucidum* were higher than those in substitute-cultivated varieties of *G. lucidum*. The fruiting bodies exhibited higher phytochemical contents than the spores in *G. lucidum*. The current study provides useful information on mushroom cultivation and the effective utilization of *G. lucidum* in food processing.

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