

## Effect of Temperature and pH on Mycelial growth of *Ganoderma lucidum* (Leyss. ex Fr. Karst)

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**ABSTRACT:** Different temperature regimes and substrate pH levels were evaluated for optimization of mycelial growth. The *G. lucidum* is an important medicinal mushroom which can grow at a wide range of temperature; during this study, maximum radial growth was achieved with the temperature of  $30\pm 1^\circ\text{C}$  (45 mm) followed by  $35\pm 1^\circ\text{C}$  (42.2 mm),  $25\pm 1^\circ\text{C}$  (31.1 mm) and  $40\pm 1^\circ\text{C}$  (23.8 mm) after 12 days of incubation. During the evaluation of different pH levels of substrate, maximum mycelial growth of *G. lucidum* was recorded when pH of the substrate was 5.5 (45 mm) followed by 5.0 (42.7 mm), 6.0 (41.3 mm) and 4.5 (24.8 mm) after 12 days of incubation. The optimum range of pH was between 5.0 and 6.0, while at pH 4.5 the mycelial growth was highly retarded. The studies depicted that; a substrate mixture (wheat straw + saw dust) having a 5.5 pH, upon incubation at  $30\pm 1^\circ\text{C}$  upto 12 days supported maximum mycelial growth.

**Keywords:** *Ganoderma lucidum*, temperature, pH, mycelial growth

### INTRODUCTION

*Ganoderma lucidum* (Fr.) Karst (Polyporaceae) is a medicinal mushroom. All parts of this mushroom namely spore; mycelium and fruiting bodies are used for health purpose and for pharmaceutical uses. The medicinal mushrooms are commonly prepared either as hot water extract, concentrate or in powdered form [12]. In India, it is also called by different names like "Jarh Phorh" while in Haryana, popularly called "Satpatra" and "Hirdo". In India ethno-medicinal value of *G. lucidum* was first reported by Harsh *et al.* [5]. Current world production of *G. lucidum* is around 6000 tones, half of which comes from China [17]. World trade in this mushroom is in the range of 1.5 billion US\$, while it is about Rs.120 crores per annum in India [3]. *G. lucidum* is probably the first medicinal mushroom to gain importance in India. An attempt has been made in India to study the potential of medicinal mushrooms as an additional crop towards diversification. Most of the mushrooms are being cultivated on agro-residues like sawdust/wood chips/wheat straw/paddy straw. In India, these raw materials are available in plenty and the country produces about 600 million tones of crop residues per year [14]. Indian conditions are quite congenial for

cultivation of medicinal mushrooms and this may fetch more returns in the market [15]. To determine the optimal conditions and specific requirements for mycelial growth and development of this mushroom, physiological studies are necessary. Temperature is one of the most important factors for the mycelial growth, fruiting, and quality of mushroom. The genus *Ganoderma* has most divergent temperature requirements known in any genus of the cultivated mushrooms. The effect of environmental conditions on the mycelial growth of *G. lucidum* was investigated in shake flask cultures and it grew well in the temperature range of  $30-35^\circ\text{C}$  [7]. Adaskaveg and Gilbertson [1] reported that it has an optimum temperature range of  $30-34^\circ\text{C}$  with the maximum growth temperature of  $37^\circ\text{C}$  and exhibited the highest growth rate of 7-8 mm/day. *G. lucidum* is a mesophilic fungus with a temperature range of  $0-50^\circ\text{C}$  and an optimum between  $15^\circ\text{C}$  and  $40^\circ\text{C}$  as observed by Griffin [4]. Similarly Rai [11] found that  $35^\circ\text{C}$  is optimum for its mycelial growth. On the other hand, temperature range of  $28-30^\circ\text{C}$  has been reported as optimum for the vegetative growth of *G. lucidum* by Dadwal and Jamaluddin [2]. Whereas, Veena and Pandey [16] reported that  $30\pm 1^\circ\text{C}$  was optimum for

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the mycelial growth and cultivation of *G. lucidum*. Song *et al.* [13] observed that *G. lucidum* had maximum mycelial growth rate at 25-35°C while, Negi *et al.* [10] reported 32±1°C most suitable for the optimum yield of the fruiting bodies of *G. lucidum* under the high humid conditions (85-90% RH). The hydrogen-ion concentration (pH) of media/substrates influenced the growth and development of mushroom. It was found that pH definitely affected mycelial growth. A culture system having constant pH at 3 and 6 exhibited improved mycelial growth of *G. lucidum*[8]. Mishra and Singh [9] revealed that local isolates of *G. lucidum* from Uttarakhand preferred acidic pH (5.0-6.0) for their growth. Iqbal *et al.* [6] reported that the growth of fungus was maximum at pH 5.5-6.5 whereas, a pH of 4.8 has been reported as optimum for the mycelial growth of *G. lucidum*[11]. Negi *et al.* [10] observed that pH 5.5-6.5 was optimum for fruiting body yield of *G. lucidum*. Keeping in view, the scanty information available on the physiological parameter of this mushroom in India, present work was undertaken with objective of evaluation of suitable temperature and pH for optimum mycelial growth of *G. lucidum*.

## MATERIALS AND METHODS

The studies on different physiological parameters of the fungus *G. lucidum* were conducted under *in vitro* conditions. The culture of *G. lucidum* was obtained from DMR, Solan (H.P.). The Potato Dextrose Agar (PDA) medium slants were inoculated with this culture under aseptic conditions and incubated at 30±1°C. Culture of *G. lucidum* was maintained on potato dextrose agar medium at 4±1°C. The mushroom (*G. lucidum*) was cultured on substrate wheat straw + saw dust (1:1) as a medium to carry out the experiments of different temperature and substrate pH for optimum growth of *G. lucidum*. The required amount of substrate wheat straw + saw dust (1:1) as a medium, having desired

moisture content was selected and sterilized in an autoclave and five gram substrate was kept in sterilized Petri plates. After that, these plates were inoculated under aseptic conditions with five mm mycelial discs of actively growing culture of *G. lucidum*. The plates were incubated at different temperatures, *viz.*, 25±1°C, 30±1°C, 35±1°C and 40±1°C. The observations for mycelial growth were recorded at an interval of 24 hrs. As above, the substrate wheat straw + saw dust (1:1) as a medium, having desired moisture content was taken and the different pH, *i.e.* 4.5, 5.0, 5.5 and 6.0 were adjusted by using standard normal solution of NaOH and HCl and sterilized. Each Petri plates had five gram substrate and these plates were inoculated under aseptic conditions with five mm mycelial discs of actively growing culture and incubated. The observations for mycelial growth were recorded at an interval of 24 hrs.

## RESULTS AND DISCUSSION

Prior to domestication of the fungus it is important to know the various physiological requirements for its vegetative growth. Hence *in vitro* different temperature and substrate pH were studied and results are presented under following tables. The observation regarding influence of different temperature regimes on mycelial growth were recorded under *in vitro* conditions by culturing the fungus in Petri plates having wheat straw + saw dust (1:1) as substrate. The radial growth was recorded for each treatment and data thus obtained after analyses are presented in Table 1.

The perusal of the results indicated that *G. lucidum* can grow at all the temperature evaluated in this study. However, the maximum growth was achieved with the 30±1°C (45 mm) followed by 35±1°C (42.2 mm), 25±1°C (31.1 mm) and 40±1°C (23.8 mm) after 12 days of incubation. Thus, a temperature of 30±1°C was found to be the most suitable for mycelial growth

Table 1  
Effect of different temperature on radial growth of *G. lucidum*

Sr. No.	Temperature (°C)	Radial growth* (mm) after days									
		3	4	5	6	7	8	9	10	11	12
1.	25	0.0	1.5	4.1	6.8	11.2	15.8	20.2	24.5	27.1	31.1
2.	30	2.7	4.9	8.4	16.7	21.2	25.3	31.0	37.1	42.9	45.0
3.	35	1.5	3.6	6.7	14.2	18.3	22.2	28.2	33.5	38.6	42.2
4.	40	0.0	1.3	3.2	5.4	8.4	11.2	15.1	16.7	20.1	23.8
5.	CD (p=0.05)	0.4	0.5	0.8	0.7	0.7	1.2	0.9	1.0	0.8	0.7

\*Average of five replications

Note: The temperature was maintained at ±1°C for the different treatments.

of this mushroom which showed maximum radial growth of 45 mm after 12 days of incubation and growth was significantly higher than at other temperature taken in this experiment. Similar results have been reported by Veena and Pandey [16], who observed optimum mycelial growth of *G. lucidum* at a temperature range of 30-35°C. Song *et al.* [13] observed that *G. lucidum* had maximum mycelial growth rate at 25-35°C, while Negi *et al.* [10] reported 32±1°C was most suitable for the optimum growth of *G. lucidum*. Hence, the present studies are in agreement with the work done by earlier workers.

To find out the suitable pH for the growth of *G. lucidum*, the substrate pH was adjusted to different pH levels, viz., 4.5, 5.0, 5.5 and 6.0. The results presented in Table 2, indicates that *G. lucidum* grow at pH range of 4.5 to 6.0. However, the maximum growth was achieved when pH of the substrate was

5.5 (45 mm) followed by 5.0 (42.7 mm), 6.0 (41.3 mm) and 4.5 (24.8 mm). So, the pH of 5.5 was found to be the most suitable for mycelial growth of *G. lucidum* which showed maximum radial growth of 45 mm after 12 days of incubation. This radial growth was significantly more than the radial growth at all other pH treatments. All the observations of radial growth statistically differed from each other.

In the present investigation the maximum mycelial growth of *G. lucidum* were recorded at pH 5.5 followed by 5.0, 6.0 and 4.5. The findings are agreed with the studies of earlier workers [9, 10]. While, Rai [11] reported that pH 4.8 was optimum for the mycelial growth of *G. lucidum*. Thus, from the above results it was concluded (Table 3) that, a mixture of wheat straw + saw dust substrate in equal proportion having a 5.5 pH upon incubation at 30±1°C upto for 12 days supported maximum radial mycelial growth of *G. lucidum*.

**Table 2**  
Effect of different pH on radial growth of *G. lucidum*

Sr. No.	pH	Radial growth* (mm) after days									
		3	4	5	6	7	8	9	10	11	12
1.	4.5	1.2	2.9	5.6	7.7	9.0	10.9	12.1	16.6	21.3	24.8
2.	5.0	2.0	4.0	9.2	15.5	20.3	24.2	28.2	32.3	38.4	42.7
3.	5.5	2.8	5.2	10.7	17.6	22.1	26.5	31.4	36.8	42.8	45.0
4.	6.0	2.1	3.6	8.6	13.3	18.8	22.6	25.5	31.2	36.3	41.3
5.	CD (p=0.05)	0.5	0.6	1.0	1.0	0.9	1.1	1.0	0.9	0.9	1.0

\*Average of five replications

**Table 3**  
Effect of different temperature and pH on mycelial growth of *G. lucidum*.

Sr. No.	Radial growth* (mm) after 12 days			
	Temperature (°C)	Growth	pH	Growth
1.	25	31	4.5	25
2.	30	45	5.0	43
3.	35	42	5.5	45
4.	40	24	6.0	41

\*Average of five replications

Note: The temperature was maintained at ±1°C for the different treatments.

## SUMMARY AND CONCLUSION

*G. lucidum* can grow at a wide range of temperature, maximum mycelial growth was obtained at 30±1°C followed by 35±1°C, 25±1°C and 40±1°C. Among the different pH levels of evaluated substrate, maximum mycelial growth of *G. lucidum* was recorded at a pH of 5.5 and range was between 5.0 and 6.0, while at pH 4.5 the mycelial growth was highly retarded. Thus, a temperature of 30±1°C and a pH of 5.5 were found most suitable for maximum mycelial growth of *G. lucidum*.

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