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A NOVEL METHOD OF ECONOMICAL CULTIVATION OF MEDICINALLY IMPORTANT MUSHROOM, *GANODERMA LUCIDUM*

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ABSTRACT: *Ganoderma lucidum* has been widely used as a herbal medicine in many pacific countries. It has been worshipped as a kind of herbal medicine, the emperors of the great Japanese and Chinese dynasties drank with their special teas and mushroom concoctions to achieve greater vitality and longer life. A protocol has been developed for the cultivation of *G. lucidum* on billets of Poplar (*Populus deltoides*). The advantage of the present method of cultivation is that the side branch piece obtained after pruning and lopping of poplar trees used which is an easily available material in poplar growing areas of north India. The economics and profitability of *G. lucidum* cultivation has been also worked out.

INTRODUCTION: *Ganoderma lucidum* (Curt.: Fr.) P. Karst. has been widely used as a commercial herbal medicine for promoting health and longevity in countries like Japan, Malaysia, Vietnam and China. Tribes of central India have also been using the extract of this fungus for the treatment of joints pain, cataract and hydrocele [10]. It has been regularly used as anti-inflammatory agent and to cure tumors and regularly found as an adulterant in another folk medicine called Phansomba (*Phellinus* species) [1]. It is medicinally active mushroom and its therapeutic effects include anti-viral, anti-bacterial, blood pressure regulation, diabetes, asthma, allergies, cardio vascular disorders, kidney tonic, nerve tonic, hepatoprotective and chronic bronchitis, migraine [5, 6].

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Due to its wide medicinal uses it is cultivated artificially. The first attempt to cultivate *G. lucidum* artificially was made by Naol in 1971. Different substrate In India [4, 19] have successfully cultivated fruiting bodies of *G. lucidum* on different substrates like, wood logs and woodchips and sawdust. However no significant efforts were made in India to develop a technology for economical cultivation of *G. lucidum*.

It is a cosmopolitan fungus with a very wide host range, more than 144 tree species, makes this fungal species one of the most destructive pathogen as it adapts wide climatic conditions [8]. It is a wood rotting fungus causes root rot disease in *Populus deltoids* (Marsh.) and other tree species [7]. Poplar, commonly known as Cottonwood Poplar, is short-lived but the fastest-growing commercial agro forestry species in India [3, 16].

Sawdust of various tree species have been used for the cultivation i.e. *Albizia procera, Albizia richardiana, Alnus nepalensis, Bombax ceiba, Borasus flabellifer, Dalbergia sisoo, Eucalyptus*

camaldulensis, Mangifera indica, Shorea robusta and their mixed sawdust were also evaluated as the substrate [9, 11]. Different agriculture and forestry wastes such as saw dust and wood chips alone and in combination with rice bran, wheat bran and finger millet or ragi (*Eleusine coracana*) powder for the purpose of cultivation were also utilized [20,21].

For the purpose of increasing biological yield while reducing the time required for mushroom production, supplementation of substrate becomes one of the major aspects of mushroom cultivation [19].

In the present paper, successful cost effective cultivation of *G. lucidum* on poplar wood within 70-80 days is being reported for the first time.

MATERIAL AND METHOD:

Isolation of pure culture: Pure culture of *G. lucidum* was isolated from fruiting body collected from *D. sissoo* (Roxb) trees. Isolation was carried out on Potato Dextrose Agar (PDA) medium.

Preparation of inoculum: Used tea leaves and wheat bran were used as the inoculum medium [2, 12]. Used tea leaves were thoroughly washed for 3-4 hours in running water to remove the impurities. Tea leaves and wheat bran (1:1v/v) supplemented with water to maintain the required moisture were filled in polypropylene bags.

The polypropylene bags were sealed with rubber bands and autoclaved for 15-20 minutes. After cooling, polypropylene bags were inoculated with small discs (5 mm) of pure culture and incubated in a B.O.D. incubator at 25±1ºC for 15 days.

Spawn production: Billets of Poplar 10-15 cm length and 4-5 cm thickness were dipped in 1% malt extract solution overnight, packed in polypropylene bags and autoclaved at 15 lbs for 20-25 minutes. After autoclaving, the billets were cooled at room temperature and inoculated with inoculum of *G. lucidum* prepared on used tea leaves and wheat bran. The inoculated billets were incubated in an incubator at 25±1ºC for 15-17 days.

Cultivation: For cultivation a low cost mist chamber was prepared. A sand bed was prepared at the base of the chamber. After complete colonization, the billets were exposed and buried in the sand bed vertically and then covered with a thin layer (1-2 cm) of unsterilized garden soil, covered with a chamber, made up of bamboo sticks and polythene sheet.

The sand bed was watered twice daily maintain the humidity of 60-70% with temperature 25-30ºC. These conditions continued throughout the growing period.

Biological Efficiency- Biological efficiency[14] of harvested fruiting bodies was calculated by following formula;

Biological Efficiency= (Fresh weight of fruiting body) / (Dry weight of substrate) × 100

RESULTS AND DISCUSSION: The billets of poplar were completely colonized (**Fig. 1**) in 15-17 days at 25±1ºC with relative humidity 70-80 %. After colonization the billets were exposed and buried in sand bed and covered with soil in low cost mist chamber. After 15-17 days of burying of billets, the first fruiting initials (primordia) began to emerge as pin heads (**Fig. 2**), whitish to golden in color. Formation of antler took further 10-12 days. The emerging antlers were reddish brown in color.

Growth was slow, yet noticeable from day-to-day. Once the desired height of stipe (5-6cm) has been achieved, the environment was altered to reduce the level of carbon dioxide to intiate the cap formation by opening windows. Cap formation (**Fig. 3**) took another 15-17 days.

The margins of matured fruiting bodies turned reddish brown from whitish to golden (**Fig. 4**) and were harvested after 15-17 days. This whole process of cultivation took 70-80 days to harvest 1st mature crop (**Table 1**). The yield (Biological Efficiency) of mature fruiting bodies was 22 % (Dry weight of substrate was 100g and fresh weight of fruiting bodies in three flushes was 22 g).

TABLE 1: CULTIVATION CYCLE OF *G. LUCIDUM*

Spawn Run	Primordial Formation	Antlers Formation	Cap Formation	Fruiting Body Development	Cropping Cycle
Incubation temperature: 22-27ºC Relative humidity: 70-80% Duration: 15-17 days	Incubation temperature: 22-27ºC Relative humidity: 70-80% Duration 15-17 days	Incubation temperature: 22-27ºC Relative humidity: 70-80% Duration 10-12 days	Incubation temperature: 22-27ºC Relative humidity: 65-75% Duration:15-17 days Fresh air exchange to maintain CO_2 level	Incubation temperature: 22-27ºC Relative humidity: 60-70% Duration 15-17 days	In 70-80 days

1 **2** **3** **4**

FIGURES 1–4: 1: FULLY COLONIZED FRUITING BODY. 2: FIRST APPERANCE OF ANTLERS. 3: CAP FORMATION. 4: MATURED FRUITING BODY

Economics for cultivation and processing of *Ganoderma lucidum*: The economics of cultivation of *G. lucidum* has been estimated. In order to evaluate this, its production statistics and cost of processed products (medicine in the form of capsule) has been calculated (**Table 2**). The production cost of this fungus includes the growing cost i.e. cost of the land, raw material (billets), energy consumption, financial and man power cost, etc. [15].

Area for growing 36 billets (about 5"×2-3"or 12.7×5-7.5 cm)

Total area for growing 36 billets = $1\times1m^2$

Distance between 2 billets = 5 inch (12.7cm)

Cropping cycle: In 1st flush, from 36 billets in 75 days, one can get 36 fruiting bodies (1st crop).

In 2nd flush, from the same 36 billets in next 30 days, 26 fruiting bodies can be harvested (2nd crop).

In 3rd flush, in the next 30 days, 16 fruiting bodies can be harvested (3rd crop).

In total from 36 billets in 135 days, 78 fruiting bodies can be cultivated.

Dry weight of fruiting body/billet = 6 g (Av.)

Dry weight of 78 fruiting body = 78×6 = 468 g

In 135 days, 468 g of dried *G. lucidum* can be produced.

Capsule Preparation: 200 mg powder is used for preparing 1 capsule so from 468g (468000 mg) powder, 2340 capsules can be made. Details of production cost are given in Table 2.

Output cost:

Selling price of 1 capsule in market = Rs. 2.5/-

Selling price of 2340 capsule in market= Rs.5850/-

Total profit = output cost - input cost

= Rs. 5850-1718

= Rs. 4132/-

It can be said that Rs. 4000/- can be earned through cultivation of *G. lucidum* from one sq. meter area

in 135 days. Profitability of *G. lucidum* cultivation was worked out. The earning rate was 66.46 % if cost of land is included and 79.16 % without cost of land **(Table 3).** It can be said that if the cultivation is done in his/her own land then there will be maximum benefit to the grower.

TABLE 2: PRODUCTION COST OF *G. LUCIDUM* CULTIVATION

Item	Rs.
Man power cost (Isolation of the fungus + Watering / Sand / Soil)	200
Spawn preparation (Billets, Polypropylene bags, Autoclaving)= Rs. 6/ piece	216
Low cost moist chamber (Bamboo + Polythene sheet	200
Capsule making and packaging	
Readymade empty gelatin capsules (Rs. 100/ 1000 piece)	234 (for 2340 capsule)
Filling charge (Rs. 1/capsule)	234
Bottles (capacity 60 capsules/bottle) @ Rs. 2/-	78 (39 bottles)
Labelling (printing + paper/bottle) @ Rs. 4/-	156 (39 bottles)
Designing of label (One time)	400
Total Capsule making + packaging	1102
Total input cost (Cultivation+ Capsule making)	1718

TABLE 3: ANNUAL COST-BENEFITS RELATIONSHIP OF *G. LUCIDUM* CULTIVATION IN NORTH INDIA

Production cost per year		Yearly Production (kg/m^2)	Value of sale	Earning rate
Without cost of the land	Rs. 3282/-	1.26	Rs. 15750/-	79.16%
With cost of the land*	Rs. 5282/-	1.26	Rs. 15750/-	66.46%

***** Cost of land = Rs. 2,000/- per sq. m. (in urban/semi-urban areas in north India). (1USD = Rs. 60)

During poplar tree cultivation the side branch are regularly pruned. The advantage of the present method of cultivation is that the side branch piece obtained after pruning and lopping of poplar trees can be used which is an easily available material in poplar growing areas of north India. The alternate method of using sawdust/wood chips has been commercially exploited in Malaysia [17] for cultivation though good yet the availability of raw material in bulk is a problem in India.

Rai [13] has used this method in India but the fruiting cycle was beyond 100 days. Similarly [4, 18] have used wooden logs and chips for the cultivation but the fruiting cycle reported is more than 130 days. In the present study the fruiting cycle has been brought down to 70 – 80 days, the lowest period reported so far. Additionally, Poplar wood has been used for the first time for successful cultivation of *G. lucidum*.

The cost benefit analysis indicates that *G. lucidum* cultivation is a profitable venture and will provide rich dividends to the grower. At present the Indian market is monopolized and dominated with products of *G. lucidum* from DXN, Malaysia and from Chinese products.

So there is immense potential for local consumption as well as for exploring export potential.

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REFERENCES:

1. Bhosle S, Ranadive K, Bapat G, Garad S, Deshpande G. and Vaidya J: Taxonomy and Diversity of *Ganoderma* from the Western parts of Maharashtra (India). Mycosphere 2010; 1: 249–262.
2. Bisht NS and Harsh NSK: Use of waste tea leaves as an aid to culture of some wood rotting fungi. International Biodeterioration Bulletin 1981; 17: 77-78.
3. Chauhan SK, Brar MS and Sharma R: Performance of poplar (populus deltoides) and its effect on wheat yield under agroforestry system in irrigated agro-ecosystem, India. Caspian J. Env. Sci. 2012; 10:53-60.
4. Dadwal VS and Jamaluddin: Cultivation of *Ganoderma lucidum* (Fr.) Karst. Indian Forester 2004; 130: 435-440.
5. Deepalakshmi K and Mirunalini S: Therapeutic properties and current medical usage of medicinal mushroom: *Ganoderma lucidum.* IJPSR 2011; 2: 1922-1929.
6. Fakhsheena A, Razvi N, Yasin H, Ahmad A, Sherwani MA, Khan NR and Arshad S: Causes of migraine in karachiites and its treatment from mushrooms. Int J Pharm 2012; 2(4): 706-711.
7. Farzamisepehr M, Ghorbanli M and Mohammadi M: Physiological Characters of *Populus deltoids* Marsh at Different Seasons in North of Iran. World Applied Sciences Journal 2012; 17: 557-565.

8. Fernando KMEP: The host preference of a *Ganoderma lucidum* strain for three tree species of Fabaceae family; *Cassia nodosa*, *Cassia fistula* and *Delonix regia*. Journal of the National *Science* Foundation of Sri Lanka 2008; 36: 323-326.
9. Gurung OK, Budathoki U and Parajuli G: Effect of Different Substrates on the Production of *Ganoderma lucidum* (Curt.:Fr.) Karst. Our Nature 2012; 10 191-198.
10. Harsh NSK, Rai BK and Tiwari DP: Use of *Ganoderma lucidum* in folk medicine. Tropical Biodiversity 1993; 1:324-326.
11. Hossain K, Sarker NC, Kakon AJ, Khan AS and Ahmed S: Cultivation of Reishi Mushroom (*Ganoderma lucidum*) on Sawdust of Different Tree Species. Bangladesh J. Mushroom 2009; 3: 1-5.
12. Peksen A and Yakupoglu G: Tea waste as a supplement for the cultivation of *Ganoderma lucidum*. World J. Microbiology Biotechnology 2009; 25: 611-618.
13. Rai RD: Successful cultivation of the medicinal mushroom Reishi, *Ganoderma lucidum* in India. Mushroom Research 2003; 12:87-91.
14. Royse DJ: Effect of spawn run time and substrate nutrition on yield and size of the shiitake mushroom. Mycologia 1985; 77: 756-762.
15. Singh R, Bishnoi DK and Singh A: Cost Benefit Analysis and Marketing of Mushroom in Haryana. Agricultural Economics Research Review 2010; 23:165-171.
16. Singh S: Study of diversity and cultivation of *Ganoderma lucidum.* Ph. D. Thesis, F.R.I. (Deemed) University 2013; 155.
17. Stamets P: Growing gourmet and medicinal mushrooms. Ten Speed Press, Berkeley, Third Edition 2000.
18. Tiwari CK, Meshram PB and Patra AK: Artificial Cultivation of *Ganoderma lucidum*. Indian Forester 2004; 130:1057-1059.
19. Tripathy A, Sahoo TK and Begera SR: Yield evaluation of paddy straw mushrooms (*Volvoriella* spp.) on various lignocellulosic wastes. Botanical Research Inter. 2011; 4(2):19-24.
20. Veena SS and Pandey M: Evaluation of the locally available substrate for the cultivation of Indigenous *Ganoderma lucidum* isolate. J. Mycol. Pl. Pathol., 2006; 36: 434-438.
21. Veena SS and Pandey M: Paddy Straw as a Substrate for the Cultivation of Lingzhi or Reishi Medicinal Mushroom, *Ganoderma lucidum* (W. Curt.: Fr.) P. Karst. in India. Int J. Med. Mushr. 2011; 13:397-400.

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