International Standard Serial Number (ISSN): 2249-6807

International Journal of Institutional Pharmacy and Life Sciences 4(4): July-August 2014

INTERNATIONAL JOURNAL OF INSTITUTIONAL PHARMACY AND LIFE SCIENCES

Pharmaceutical Sciences **Research Article……!!!**

Received: 13-06-2014; Revised; Accepted: 16-07-2014

MORPHOLOGICAL STUDIES OF *GANODERMA LUCIDUM* FROM DIFFERENT HOST TREE SPECIES

Sona Singh*, N.S.K. Harsh and Suresh Chandra

Forest Pathology Division,Forest Research Institute, Dehradun, India-248006

Keywords:

Collection, host tree species, medicinal mushroom, morphology, sporophores, S.S.I.

For Correspondence:

Sona Singh

Forest Pathology Division, Forest Research Institute, Dehradun, India-248006

E-mail:

sona.singh13@gmail.com

ABSTRACT

Ganoderma lucidum has been widely used as a herbal medicine in many pacific countries. It is a cosmopolitan fungus easily found in the root of dead and dying trees in highly variable form. It is distributed over a broad ecogeographical range and has been reported on more than 144 host tree species and in India it grows nearly on 62 different host tree species. Different natural conditions based on local environmental variations can promote phenotypic differentiation among different isolates. The sporophores of *G. lucidum* collected from different hosts showed morphological variation. During this study, sporophores were collected from 7 different host tree species from the regions of Uttarakhand and Uttar Pradesh, showed diversity in their morphological characters. There was visible variation in the morphological characters with correlation to the host These variations appear to be affected by environmental conditions as well as due to the host variability during fruiting body development.

INTRODUCTION

Medicinal mushrooms have been a part of Oriental medicines for hundreds of years as being beneficial for health. Mushrooms comprises a vast and yet largely untapped source of powerful new pharmaceutical products. *Ganoderma lucidum* in medicine was considered so promising that its medicinal value has been attested. Originally, *G. lucidum* (Traditional Chinese Medicine) was used in China, a very important component of the Chinese treasure of culture. Lately it has been largely accepted worldwide as one of a health maintaining food, especially in countries of the Pacific region, like Japan, China, Korea, Taiwan, Thailand and Malaysia,. It is economically and ecologically important as a source of medicinal and neutraceutical products. In India, *Ganoderma* is reported to be used against cataract, joints pain and hydrocoele by the tribal people from central India (Harsh *et al*., 1993).). It has been regularly used as anti inflammatory agent and to cure tumors, while it is regularly found as an adulterant in another folk medicine called Phansomba (*Phellinus* species) (Bhosle *et al*., 2010). This basidiomycetous fungus is found to be pathogenically associated with most of the tree species. The wide host range, more then 144 tree species, makes this fungal species one of the most destructive pathogen as it adapts wide climatic conditions (Fernando, 2008). It grows throughout India and reported on 62 tree hosts (Kumari and Harsh, 2004).

The fruiting body of *G. lucidum* is easily recognized by its shiny orange red or maroon waxy crust and the presence of a stipe. When the stipe reaches its full length, a horizontal pileus of varying size and shape is formed. The naturally produced basidiocarps show various morphological characteristics. The colour of the pileus surface and hymenophore varies from deep red, non – laccate, laccate and light yellow to white, and the morphology also differs between the isolates. The morphological variation appears to be affected by environmental conditions during basidiocarp development. The manner of stipe attachment to pileus and host range also varies (Ryvarden, 1995). At present, little information is available of the significance of diversity of this species from the north Indian states, in context to its medicinal and neutraceutical value. This work provides useful information with respect to the morphological variability of *G. lucidum.*

EXPERIMENTAL

Collection of basidiocarps

Extensive field surveys were conducted for collection of basidiocarps of *G. lucidum* from different parts of Uttarakhand and Uttar Pradesh. They were collected from plantations,

natural forests and road side trees. The details of the host species, attachment position of the fruit bodies and their colour, size, shape and locality of occurrence were noted. The fruit bodies were brought to the laboratory in paper bags, cleaned and dried under the sun. It took about 24 – 30 hours to get the fruiting bodies completely dried.

Maintenance of basidiocarps

After drying, the fruiting bodies were packed inside paper bags, properly numbered and stored inside a steel almirah with cages for further studies. Naphthalene balls were kept inside the packets for protection against insects. The fruiting bodies were exposed to sun after every six months.

Morphological Study

Morphological studies include the study of shape, size, colour and number of pores in hymenial layer of the fruiting bodies. Photographs were taken using a digital camera in field. The shape of basidiocarps and attachment of the stipe were described as per the descriptors given by Ryvarden and Johansen (1980). The colour of the pileus, stipe and hymenophore were studied by using Ridgway's colour chart. The dimensions of the pileus and stipe were measured by using a centimeter scale. Number of pores was counted in mm scale by using a hand lens. Context colour and composition were also studied. Spore size index (S.S.I.) was calculated as per the formula given by Gottlieb and Wright (1999).

RESULTS AND DISCUSSION

A total of 20 fruiting bodies were collected from different host tree species and regions of Uttarakhand (U.K.) and Uttar Pradesh (U.P.) during and after rainy season. Ten basidiocarps were collected from each state on 7 different host tree species (Table 1).

Table: 1. Details of *Ganoderma lucidum* basidiocarps

State	Isolate no.	Host Tree Species	Location
Uttarakhand	1	*Delonix regia* (Hook.) Raf	Near Gurukul Kangri, Haridwar,
	2	*Terminalia bellerica* Roxb.	Basant Vihar, Dehradun
	3	*Grevillea robusta* A. Cunn.	Asan Barrage, Dehradun
	4	*Mangifera indica* L.	Near Jugdad Petrol pump, Jwalapur
	5	*D. regia*	Haldwani
	6	*Cassia fistula* L.	Haldwani
	7	*D. regia*	Haldwani,
	8	*C. fistula*	Haldwani
	9	*Dalbergia sissoo* Roxb.	I.G.N.F.A., Dehradun
	10	*D.sissoo*	I.G.N.F.A., Dehradun

Uttar Pradesh	11	*D. sissoo*	Sunderpur on way to Bihanpur
	12	*D. regia*	Fatehpur near Chutmalpur
	13	*Eucalyptus* hybrid	Fatehpur near Chutmalpur
	14	*D. sissoo*	Chutmalpur, Saharanpur
	15	*D. sissoo*	Haroda, Saharanpur
	16	*M. indica*	Saharanpur
	17	*M. indica*	Chutmalpur, Saharanpu
	18	*D. sissoo*	Near Bhagawanpur, Roorkee Road via Chutmalpur
	19	*M. indica*	Ibrahimpur, Haroda
	20	*D. sissoo*	Jhansi

Different host tree species of *G. lucidum*

Bsidiocarps of *G. lucidum* were collected from 7 host tree species. Maximum collection of 7 basidiocarps was made on *D. sissoo* followed by *D. regia* (4), *M. indica* (4), *C. fistula* (2) and only one fruiting body was collected from *Eucalyptus* hybrid, *T. bellerica* and *G. robusta*.

Morphological characters

All the 20 fruiting bodies of *G. lucidum* showed various morphological characteristics. The morphological studies have been broadly categorized in two groups.

I. Macro-morphology
II. Micro-morphology

Macro-morphology includes the study of shape, size and colour of the different parts of basidiocarps. The size and the colour of the basidiocarps showed distinct variation between the specimens collected from different locations as well as hosts. The position of stipe attachment to the pileus also varied. The pileus of normal fruiting body is laterally attached to the stipe but central attachment of the stipe was also found in some specimens. Number of pores present in hymenial layer of the fruiting bodies counted per mm also varied. In micro-morphology, structure of pileal crust, context (Hyphal System-Trimitic) and shape of basidiospores were studied. Difference in cuticle structure and Spore Size Index (S.S.I.) were also a helpful character for species identification. The taxonomic description is given below: Details of morphological variations in the fruiting bodies have been summarized in Table 2.

Ganoderma lucidum (Curtis: Fr.) P. Karst. *Rev. Mycol*. **3** (9): 16-18. 1881. (Fig. 1)

Annual, stipitate, brilliantly laccate, pileus surface: concave, woody; margin: rounded, lateral, marginal, burnt sienna (Plate II), buckthorn brown (Plate XV), chest nut (Plate II), cinnamon rufous (Plate XIV), liver brown (Plate XIV), hay russet (Plate XIV), kaiser brown

(Plate XIV), liver brown (Plate XIV), hay's brown (Plate XXXIX), mummy brown (Plate XV) (all colours after Ridgway's Colour Chart) thick, 5.0-19.0×4.0-12.0×1.0-4.0 cm; hymenial surface: light orchraceous buff (Plate XV), light buff (Plate XV), light orchraceous salmon (Plate XV), pale orchraceous buff (Plate XV), pale pinkish buff (Plate XXIX); pores circular, 2-7 per mm, 120-360 µm dia.

Isolate collected from *D.sissoo*

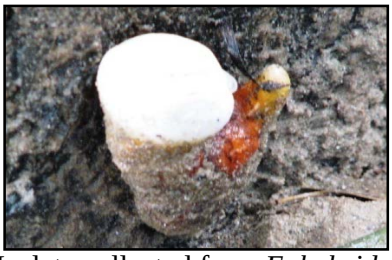
Isolate collected from *D.regia*

Isolate collected from *T.bellerica*

Isolate collected from *G.robusta*

Isolate collected from *M.indica*

Isolate collected from *C.fistula*



Isolate collected from *E. hybrid*

Fig: 1 Basidiocarps of *G. lucidum* from different host tree species

Table: 2. Variations in morphological characters of basidiocarps of *G. lucidum*

S. No.	Host tree spesies	Fruit body characteristics	Colour of the pileus	Size of the pileus			Colour of the margin	Attachment	Colour of the stipe	Stipe		Hymenial layer colour	No. of pores/ mm	Spore Size Index
				Length (cm)	Breadth (cm)	Width (cm)				Length (cm)	Thickness (cm)			
1	*D.regia*	Imbricate	Burnt Sienna	19.0	12.0	2.0	Light Ochraceous Buff	Lateral	Russet	1.5	2.5	Buckthom brown	2-5	1.4
2	*T. bellerica*	Sessile	Kaiser Brown	7.0	4.0	1.0	Light Ochraceous Buff	Basidiocarps was sessile, no stipe was present				Light buff	4-6	1.3
3	*G.robusta*	Stipitate	Buchtho m Brown	10.0	6.0	3.5	Light Ochraceous Buff	Lateral	Liver Brown	4.0	3.0	Hymenial layer not developed		
4	*M. indica*	Stipitate	Chest nut	8.0	5.0	4.0		Fruiting body was immature and hymenial layer was not developed						
5	*D. regia*	Imbricate	Hay's Russet	18.0	10.0	2.0	Light Ochraceous Buff	Lateral	Liver Brown	2.5x4.0	2.5	Light ochraceou s buff	2-4	1.5
6	*C. fistula*	Sessile	Kaiser Brown	9.0	4.5	1.0	Kaiser Brown	Basidiocarps was sessile, no stipe was present				Mummy's brown	3-6	1.3
7	*D. regia*	Sessile	Kaiser Brown	19.0	8.0	1.0	Light Ochraceous Buff	Basidiocarps was sessile, no stipe was present				Buckthom brown	3-5	1.3
8	*C. fistula*	Imbricate	Cinnamo n Rufous	18.0	10.0	1.5	Light Ochraceous Buff	Lateral	Liver Brown	2.0x4.0		Mummy's brown	2-5	1.3
9	*D. sissoo*	Stipitate	Burnt Sienna	12.0	9.0	1.3	Light Ochraceous Buff	Lateral	Liver Brown	2.5x1.2		Light ochraceou s buff	2-4	1.5

10	*D. sissoo*	Stipitate	Burnt Sienna	10.0	9.0	3.0	Light Ochraceous Buff	Lateral	Liver Brown	2.0x5.0		Buckthom brown	2-5	1.4
11	*D. sissoo*	Imbricate	Hay's Brown	11.0	8.0	4.0	Light Ochraceous Buff	Lateral	Hay's Brown	2.5x2		Light buff	2-5	1.3
12	*D. regia*	Sessile	Kaiser Brown	10.0	6.0	1.0	Light Ochraceous Buff	Basidiocarps was sessile, no stipe was present				Pale pinkish buff	2-6	1.2
13	*E.* hybrid	Stipitate	Hay's Brown	16.0	10.0	2.0	Light Ochraceous Buff	Lateral	Hay's Brown	2.0x5.0		Light buff	2-5	1.4
14	*D. sissoo*	Sessile	Liver Brown	13.0	9.0	2.1	Light Ochraceous Buff	Basidiocarps was sessile, no stipe was present				Pale pinkish buff	2-5	1.5
15	*D. sissoo*	Stipiate	Chestnut	5.0	11.0	3.5	Light Ochraceous Buff	Lateral	Russet	3.0x4.0		Light ochraceou s salmon	2-6	1.3
16	*M. indica*	Sessile	Hay's Russet	17.0	11.0	3.5	Light Ochraceous Buff	Basidiocarps was sessile, no stipe was present				Light ochraceou s salmon	2-6	1.4
17	*M. indica*	Stipitate	Hay's Russet	18.0	11.0	2.0	Light Ochraceous Buff	Lateral	Russet	2.5x5.0		Light Buff	3-5	1.3
18	*D. sissoo*	Substipitat e	Hay's Russet	7.0	5.0	2.5	Light Ochraceous Buff	Lateral	Russet	3.0x2.0		Pale pinkish buff	3-5	1.3
19	*M. indica*	Stipitate	Liver Brown	10.0	4.5	3.0	Light Ochraceous Buff	Lateral	Russet	2.5x4.5		Light Buff	3-6	1.5
20	*D. sissoo*	Sessile	Hay's Russet	15.0	6.5	3.0	Light Ochraceous Buff	Lateral	Russet	2.5x5.0		Pale pinkish buff	2-6	1.4

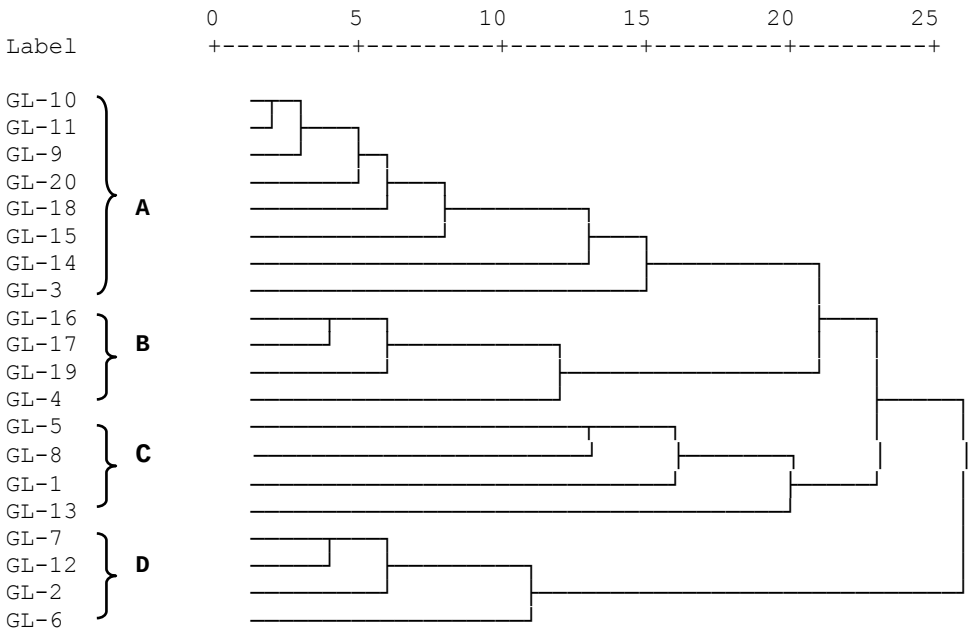


Fig: 2 Dendrogram based on morphological characters *G. lucidum*

A dendrogram (Fig.2) depicting morphological relationships among the specimens based on over all similarity of characters without taking evolutionary history into consideration was constructed considering 14 characters of 20 basidiocarps collected from 7 tree species. These twenty specimens were found to be grouped into four main clusters A, B, C and D. Seven specimens were grouped together in cluster A. All of these isolates i.e. 10, 11, 9, 20, 18, 15 and 14 were collected from the host tree species *D. sissoo* showed similar characters. In cluster B, four isolates i.e. 16, 17, 19 and 4 were found from the host tree species *M. indica.* Meanwhile, in cluster C, two isolates 5, 8 were from *D. regia* and isolate no. 1, 13 were from different host tree species. Again isolate no.7 and 12 lies in cluster D, from *D. regia* showed the morphological similarity. Whereas, isolate no.2 from *T. bellerica* and isolate no.6 from *C.fistula* also lied in cluster D showed same morphological features. Maximum analogy was found in isolates from *D. sissoo* and *M. indica*, as they lie in same cluster A and B. The similarity in morphological characters indicated host preference nature of *G. lucidum*, also supported by the findings of Fernando (2008). It can be concluded that *G. lucidum* is a highly variable species within same geographical region but its basidiocarps from same host tree species showed similar characters in their macro and micromorphological characters. Macroscopic and

microscopic characteristics of these collections were exactly identical with the characteristics features of *G.lucidum* which has been described previously by several authors (Wagner *et al*., 2004; Mohanty *et al*., 2011). Morphological features of basidiospores were similar to that of *G. lucidum* reported by several authors. Further, the size of basidiospores (S.S.I.) measured in the current study is comparable with the size of previous records of *G. lucidum* i.e. 1.3-1.5 (Bhosle *et al*., 2010, Gottlieb & Wright, 1999; Mohanty *et al*., 2011). The basidiospores of *Ganoderma* spp. within the family Ganodermataceae are considered as characteristic of the genus (Ji-Ding, 1989).

CONCLUSION

At present, little information is available of the significance of diversity of this species from the north Indian states, in context to its medicinal and neutraceutical value. This work provides useful information with respect to the variability of *G. lucidum*. Some characters were of use in the identification of different isolates of *G. lucidum* mentioned above such as, number of pores, pore diameter and to some extent range of the basidiospore size.The information about variability of morphological characters will help the mycologists to identify the species as some times variation in form, shape and size lead to establishing new species or confusion in identity.

ACKNOWLEDGEMENTS

This work was financed by the Forest Research Institute, Indian Council of Forestry Research & Education, Dehradun, India, 248008.

REFERENCES

1. Bhosle S., Ranadive K., Bapat G., Garad S., Deshpande G., Vaidya, J. (2010); Taxonomy and Diversity of *Ganoderma* from the Western parts of Maharashtra (India). *Mycosphere*; 1: 249–262.
2. Fernando KMEP. (2008); 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*. 36: 323-326.
3. Gottlieb A.M., Wright J.E. 1999 - Taxonomy of Ganoderma from southern South America: subgenus Ganoderma. *Mycological Research*. 103: 661-673.
4. Harsh N.S.K., Rai B.K., Tiwari D.P. (1993); Use of *Ganoderma lucidum* in folk medicine. *I. Tropical Biodiversity*. 1: 324-326.

5. Kumari S., Harsh N.S.K. (2004); Host range of *Ganoderma lucidum* in India. *Indian Journal of Forestry*. 27: 213-215.
6. Ji-Ding Zhao. (1989); The Ganodermataceae in China, Biblioheca Mycologica Band 132, *J. Cramer*, Berlin, Stuttgart, 1989.
7. Mohanty P.S., Harsh N.S.K., Pandey A. (2011); First report of *Ganoderma resinaceum* and *G. weberianum* from north India based on ITS sequence analysis and micromorphology. *Mycosphere*. 2: 469-474.
8. Ryvarden, L. Can we trust morphology in *Ganodrma*. In Buchannan, P. K., Hseu, R. S. and Moncalvo, J. M. (1994); (eds) Ganoderma systematics, phytopathology and pharmacology. Proceedings of contributed symposia 59AB: Fifth International Mycological congress, Vancouver.1995; August 14-21, pp 135-165.
9. Ryvarden L, Johansen I. (1980); A preliminary polypore flora of East Africa. Oslo Fungiflora.
10. Wagner R., Mitchell D.A., Sassaki G.L., Amazonas MALA. (2004); Link between morphology and physiology of *Ganoderma lucidum* in submerged culture for the production of exopolysaccharide. *J Biotechnol*. 2004; 114: 153-164.