Comprehensive Study on the *Ganoderma Lucidum*: A Medicinal Mushroom

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**A B S T R A C T**

Ganoderma lucidum is a medicinal and basidiomycete white rot macrofungus which has been used widely as “the mushroom of immortality”. *Ganoderma lucidum* is one of the major herbs used for the purpose of good health and longevity. It has been used widely as mushroom of immortality in Japan, China and Asian countries since ancient times and has numerous potential application for health improvement. This review article presents the comprehensive study of the *Ganoderma lucidum* with its applications.

**Keywords:** anti-cancer effect, cultivation, *Ganoderma lucidum*, polysaccharides

**Introduction**

*Ganoderma lucidum* has been recognized as an edible and medicinal mushroom and an oriental fungus, which belongs to Basidiomycota (Class: Agaricomycetes). It is mainly called as “Reishi or Manetake” in Japan, “Lingzhi” in China and “Youngzhi” in Korea (Sudheesh, Ajith, & Janardhanan, 2009)). In these countries, people appreciated *Ganoderma lucidum* also for its spiritual power along with medicinal uses as it was considered a symbol of good luck, prosperity, good health, longevity, and immortality. The Latin word lucidus means “brilliant” or “shiny” and denotes to the smoother mushroom surface and it mainly grows on dead and decaying parts and trunks of trees. It is highly useful herbs for the medicine purpose of any immune deficiency disease and has longevity for promoting health in China, Japan, and other Asian countries (KK Hapuarachchi et al., 2018). There are variety of *Ganoderma lucidum* commercial products that are available in several forms such as dietary supplements, powders, and tea (Galor, Yuen, Buswell, & Benzie, 2011). These products have a significant market value and are promoted as effective food supplements for health maintenance. This mushroom has various features like woody texture, large and dark in color with a glossy exterior.

**Biochemical Constitutes of Ganoderma lucidum**

According to various studies being conducted, it has been found that 90% portion of the total *Ganoderma lucidum* weight comprises water and remaining 10% contains other biochemical constitutes like protein about 10-40%, fat 2-8%, carbohydrates 3-28%, fiber 3.32% and ash 8-10% along with these constitutes which is also rich in elements such as calcium, minerals, phosphorus, potassium, magnesium, iron, copper, zinc and selenium which are part of 10% of the total weight of the mushroom (Zhou et al., 2007). Other than these constitutes, various molecules are also found in *Ganoderma lucidum* such as steroids, terpenoids, phenols, polysaccharides, nucleotides, and glycoproteins. All crucial amino acids and proteins particularly rich in lysine and leucine are also present. The most essential bioactive constitutes in *Ganoderma lucidum* are polysaccharides, peptidoglycans, and terpenes (Moncalvo & Ryvarden, 1997; Zhao et al., 2012).

**Habitat**

It is an annual mushroom that generally grows on a wide variety of dead or dying trees like deciduous trees especially oak, maple, elm, willow, sweet gum, magnolia, and locust. In Europe, Asia, North and South America *G. lucidum* is less frequently found on coniferous trees (eg. *Larix, Picea, Pinus*). It is also found on stumps, generally near the soil surface and occasionally on soils arising from buried roots. For the growth of mycelium of fungus, temperature plays a vital role. It should be controlled in the cultivation of mushroom. *G. lucidum* can grow at 30–34°C (Gao, Lan, Dai, Ye, & Zhou, 2004). However, the Optimum temperature for the growth of mushroom is 37°C and it has been observed that *Ganoderma lucidum* grows very rapidly at this optimum temperature at the rate of 7-8 mm/ day (Gao et al., 2004).
**History of Ganoderma lucidum Cultivation**

In 1781, *G. lucidum* was first reported by William Curtis based on the material grown in England and has been recognized as a “medicinal mushroom” in the past 2000 years and used in folk medicines of China and Japan, mainly in the treatment of hepatopathy, chronic hepatitis, nephritis, hypertension, asthma, gastric ulcers and bronchitis. In China, it has been preserved for over 4000 years as a longevity promoting tonic (Chang & Buswell, 1999). There are more than 120 *Ganoderma* species have been reported worldwide and 98 species out of 120 have been found in China (Rupeshkumar, Chettri, & Paarakh, 2016). However, two species of *Ganoderma* have been reported by (Lv, Zhao, Duan, Tang, & Li, 2012) such as *lucidum* and *sinense* have been used as lingzhi in China (Silva, 2006). Lingzhi is basically a “woody polypore” has been employed as medicinal mushroom (McMEEKIN, 2004; Pegler, 2002) and its concept is originated in India (Pegler, 2002). In traditional Chinese books, *Ganoderma* on the basis of color of fruiting body was classified into six species depending on different triterpenoid patterns such as “Kokushi (black), Hakashi (white), Sekishi (red), Shishi (violaceous), Oushi (yellow) and Seishi (blue)” (Szedlay, 2002).

**Table 1 - Classification of Ganoderma lucidum by color of fruiting bodies and their uses (Liu, Yuan, Chung, & Chen, 2002)**

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Color</th>
<th>Chinese name</th>
<th>Japanese name</th>
<th>Taste</th>
<th>Medicinal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Black</td>
<td>Kokushi</td>
<td>Kuroshiba</td>
<td>Salty</td>
<td>Improves lung function</td>
</tr>
<tr>
<td>2.</td>
<td>White</td>
<td>Hakashi</td>
<td>Shiroshiba</td>
<td>Hot</td>
<td>Protects kidney</td>
</tr>
<tr>
<td>3.</td>
<td>Red</td>
<td>Sekishi</td>
<td>Akashiba</td>
<td>Bitter</td>
<td>Acids internal organs and improves memory</td>
</tr>
<tr>
<td>4.</td>
<td>Yellow</td>
<td>Oushi</td>
<td>Kishiba</td>
<td>Sweet</td>
<td>Strengthens spleen function</td>
</tr>
<tr>
<td>5.</td>
<td>Blue</td>
<td>Seishi</td>
<td>Aoshiba</td>
<td>Sour</td>
<td>Improves eyesight and liver function</td>
</tr>
<tr>
<td>6.</td>
<td>Purple / violaceous</td>
<td>Shishi</td>
<td>Muroshikishi</td>
<td>Sweet</td>
<td>Enhances the function of eyes joints, helps complexion</td>
</tr>
</tbody>
</table>

**Table 2 - Some species of Ganoderma grown at commercial level worldwide and their characteristics**

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Name of species</th>
<th>Common name</th>
<th>Mycological characters</th>
<th>Ecology</th>
<th>Edibility</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Ganoderma</em></td>
<td>Lingzhi or Reishi</td>
<td>Pores on hymenium Cap is offset or indistinct Hymenium attachment is irregular or not applicable Stipe is bare or lacks stipe Spore print is brown</td>
<td>Saprotrophic or parasitic</td>
<td>Edible</td>
<td>(Arora, 1986)</td>
</tr>
<tr>
<td>2.</td>
<td><em>Ganoderma</em></td>
<td>Zizhi (Purple Ganoderma)</td>
<td>Pores on hymenium Cap is offset Hymenium attachment is irregular or not applicable Stipe is bare Spore print is brown</td>
<td>Saprotrophic</td>
<td>Edible but unpalatable</td>
<td>(KK Hapuarachchi et al., 2019)</td>
</tr>
<tr>
<td>3.</td>
<td><em>Ganoderma</em></td>
<td>Hemlock varnish shelf</td>
<td>Pores on hymenium Cap is flat Hymenium is adnate Stipe is bare Spore print is brown</td>
<td>Saprotrophic or parasitic</td>
<td>Inedible</td>
<td>(Mizuno et al., 1995)</td>
</tr>
</tbody>
</table>
4. **Ganoderma applanatum**  
- Bear bread or artist’s bread  
- Pores on hymenium  
- No distinct cap  
- Hymenium is decurrent  
- Lacks a stipe  
- Spore print is brown  
- Parasitic  
- Inedible  
  (Lallawmsang a & Carrasco, 2022)

5. **Ganoderma neo-japonicum**  
- Imazeki or Black lingzhi  
- Shape of fruiting body is umbrella or horseshoe  
- Spore pattern is brown  
- Flesh color of the cross section of umbrella is salmon pink to brown  
- Saprotrophic  
  (Du, Dong, Wang, & Yao, 2019)

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**Figures**  
(a) Ganoderma lucidum (Reishi mushroom),  
(b) Ganoderma lucidum life cycle and reproduction stages,  
(c) Ganoderma sinense- purple reishi,  
(d) Ganoderma applanatum- Artist's fungus,  
(e) Ganoderma tsugae- Songshan Lingzhi,  
(f) Ganoderma neo-japonicum culture slant

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**Biological applications**

*Ganoderma lucidum* has been used for various purpose to promote the health system such as for immune system regulator, anti-cancer agent, and antioxidant and stress reducer etc. Recently, this type of mushroom is widely used in traditional Chinese medicine. When *G. lucidum* is supplemented, it has anti-oxidative effects and has therapeutic effects on insulin resistance. It helps to reduce the prostate cancer risk, metabolic syndrome conditions and reduces the immune system activities when the immune system is overstimulated (H.-Z. Chen & Chen, 2004).

**Important uses of Ganoderma species**

*Ganoderma* species are extensively researched owing to their highly valuable medicinal values, chemical constituents with potential nutritional and therapeutic value (Manavalan, Manavalan, Thangavelu, & Heese, 2013). The fruiting bodies of *Ganoderma* species has been widely used as dietary supplements in some regions of the world like China, Japan, and North America (K Hapuarachchi, Wen, Jeewon, & Wu, 2016). *Ganoderma* species are rich in antioxidant compounds (Paterson, 2006) and help to reduce the oxidative damage by directly scavenging free radicals generated in the cell (Rawat, Mohsin, & Singh, 2011; Wong, Chao, Chan, Chang, & Liu, 2004). Different products made from different part of fruiting body, mycelia, or spores of *Ganoderma lucidum* are sold in several form such as tea, coffee, powder, drinks, dietary supplements, syrups, spore products, toothpastes, soaps and lotions. It has also been commercialized as a food and drug supplements which improve the body’s immune system and metabolic functions (Lai, Gao, & Zhou, 2004; Obodai et al., 2017). It was also used as Bonsai products for decoration purpose of gardens, ornaments and many other art products.
**Therapeutic applications of Ganoderma species**

Different bioactive compounds present in *Ganoderma lucidum* which are responsible for the cure of a number of pharmacological and therapeutic effects such as B-D-glucans for Immunomodulation (Singh, Doshi, Pancholy, & Pathak, 2013; Wang et al., 2002), Ganoic acid-A, E, DM, T, Q for Anti-inflammatory effect (Cao & Lin, 2002), B-D-glucans, GA-T for Anti-cancer and anti-tumor effect (Akihisa et al., 2007), chloroform extract as Antioxidant, GA-B, C, and G for anti-aging effect (Tang, Liu, Zhao, Wei, & Zhong, 2006), Ganopoly for Anti-diabetic effect, Neutral and Acidic proteins, bound Polysaccharide, Ganodermin for Antibacterial effect.

**Conclusion**

In this article, the major focus has been given on the numerous studies of *Ganoderma lucidum* that it has the potential to regulate different body systems. In this study various types of properties, benefits and applications have been discussed to understand the phenomenon of *Ganoderma lucidum*. It is worth noting that the usage of *Ganoderma lucidum* would become beneficial in modern medicinal system for improving the health.

**References**


