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Ganoderma: The wild mushroom with wonderful health benefits

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Abstract

Mushrooms are used as a nutritional rich food and used as traditional medicine to cure many life-threatening diseases since long ago. It is regarded as “Food of gods” by the Romans and a “wonder herb for the warriors” by the Greek and an “elixir of life by the Chinese”. Among all major mushrooms, *Ganoderma lucidum* is the utmost important one with various therapeutic and pharmaceutical properties. The mycelium, spores and the fruiting bodies carry the medicinal properties. It is more popular in Asian countries but the amazing attributes have widespread throughout the world. It is the new focus of interest in modern pharmacological and biochemical research in recent years. The antimicrobial, anti-diabetic, anti-aging, antioxidant, anti-allergic, anti-inflammatory, immunomodulating functions of mushroom made it more popular among the drug industries. The existence of potential bioactive compounds such as polysaccharides, triterpenoids, proteins, peptides etc have amazing health benefits against hepatitis, hypertension, asthma, gastric, insomnia etc. *Ganoderma lucidum* is proved as one of the best anti-cancer agents from decades due to its inhibitory effect on cancerous and tumour cells, protects from cell proliferation etc. This review describes about all the amazing health benefits of *G. lucidum*. But more research is required in near future to discover novel bioactive compounds and mass production of this medicine which will help the mankind.

Keywords: Ganoderma, therapeutic, bioactive, medicine, diseases

Introduction

Mushrooms are famous among the people since ancient times for its taste, delicacy, flavour and health benefits. Numerous mushrooms present in our world have wide range of medicinal values. The presence of potential bioactive compounds has opened up its path towards drug industries. Mushrooms are being used for developing numerous novel drugs to cure many more dangerous life-threatening diseases which cannot be cured by any other medicines. These pharmaceutical and therapeutic attributes have amazed the scientists to do more research on this. Several studies have described the existence of nearly 1.5million fungi in the world while 82000 are known. Among the known fungi, 5000 are edible and 2000 are safe (Kirk *et al* 2001; Hawksworth 2001) [7, 4].

Ganoderma lucidum (Fig 1 and Tab 1) is one of the most popular medicinal mushrooms for its unique characteristics throughout the world. It is known by different names such as Reishi, Lingzhi and Mannentake. This mushroom is popular mainly in China, Japan, Korea and other Asian countries. The dark, large mushroom have wood like texture and glossy exterior. In past studies, it was reported to alleviate numerous diseases by this mushroom *spp.* (Hawksworth 2001, Kingston and Newman 2005) [4, 6]. This mushroom is found mainly on a variety of dead deciduous plants.



Fig 1: *Ganoderma lucidum* or Reishi or Lingzhi

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This *Ganoderma spp.* is gained much demand in recent years for its wide medicinal properties such as anti-microbial, anticancer, anti-diabetic, anti-ageing, immunomodulating agents etc (Fig 2). Now-a-days, several medicines are available in market in different forms like powder, tea and

dietary supplements which are derived from fruiting body, mycelium and spores of the mushroom (Wachtel-Galor *et al* 2011) [13]. Several bioactive molecules produced by the cell wall of mushroom have significant medicinal attributes in developing several novel drugs.

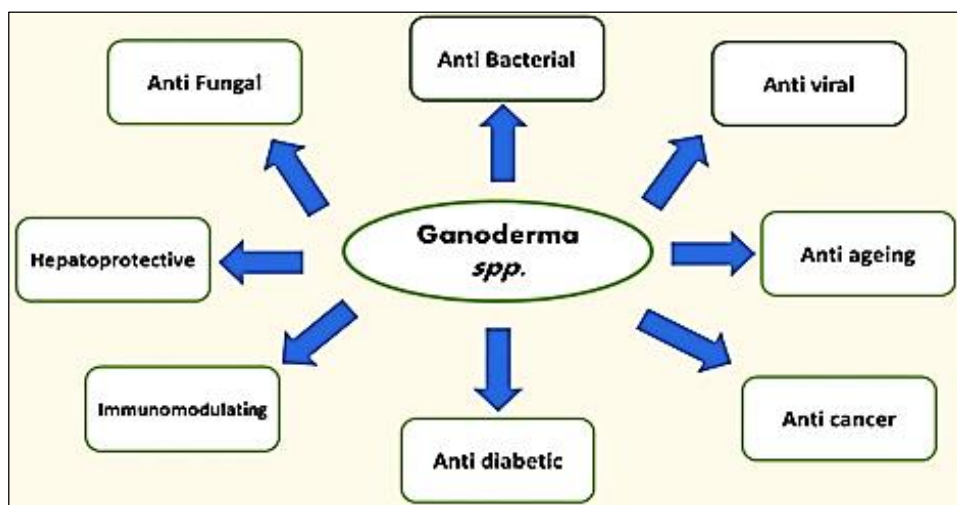


Fig 2: Medicinal attributes of *Ganoderma lucidum*

Classification

Table 1: Scientific classification of *Ganoderma lucidum*

Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Order	Polyporales
Family	Ganodermataceae
Genus	<i>Ganoderma</i>
Species	<i>lucidum</i>

Major Bioactive Agents

The mycelium, spores and fruiting body of *Ganoderma spp.* reported to contain nearly 400 biologically active agents (Fig 3) like polysaccharides, sterols, proteins, fatty acids, triterpenoids, nucleotides etc (Tab 2).

Table 2: Medical Efficacy of *Ganoderma lucidum* (Batra *et al* 2013, Deepalakshmi and Mirunalini 2011) [1, 2]

Serial No	Compound	Therapeutic affects
1	Ganodermanondiol	Anti-HIV activity
2	Lucidenic acids A, D1	Bitterness
3	Ganoderic acid A, C	Inhibition of FPT
4	Ganoderic acids R and S	Hepatoprotection activity
5	Ganoderma poly B	Immunomodulating activity, Anticancer activity
6	Cyclooctasulphur	Inhibition of Histamine secretion
7	(1-3)- β -D-glucans	Tumour inhibition and immunity booster
8	Protein-bound polysaccharides	Hepatoprotector
9	Ganopoly	Anti-diabetic
10	Chloroform extract	Ant oxidant

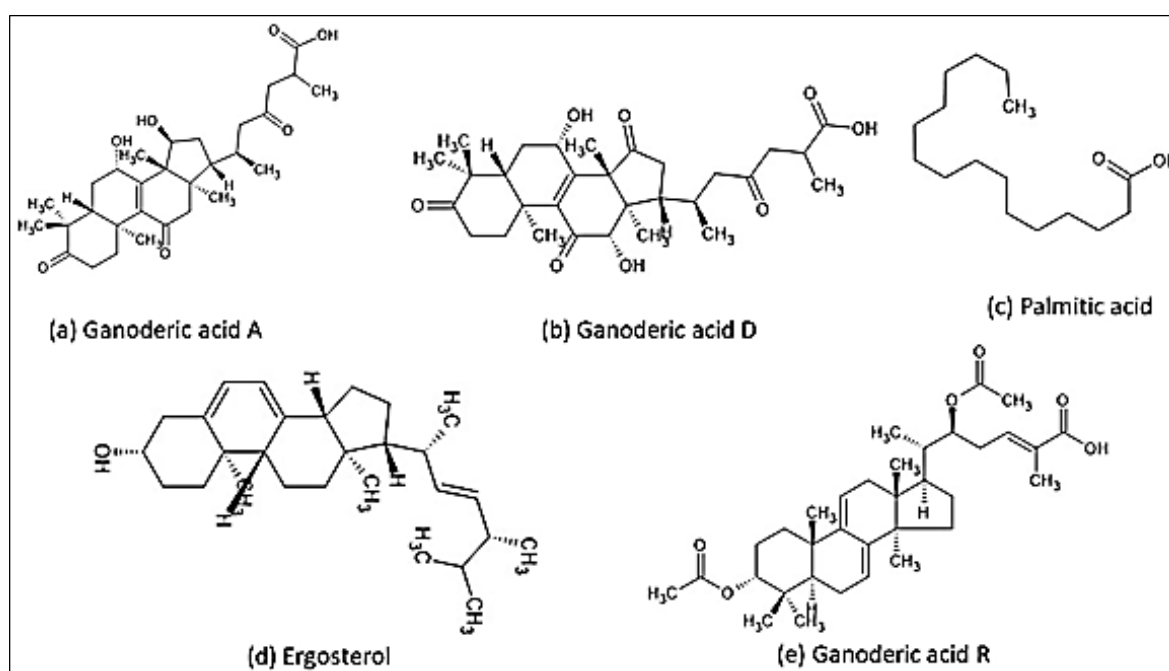


Fig 3: Chemical compounds present in *Ganoderma lucidum*

Nutritional value (Deepalakshmi and Mirunalini 2011)^[2]

Various nutrients present in *G. lucidum* is illustrated in below table 3.

Table 3: Nutritional composition of *Ganoderma lucidum*

Serial no	Major constituent	Fermented	Non fermented
1	Protein	16.5±0.7	11.0±0.5
2	Starch	25.3±0.8	64.5±1.5
3	Crude fat	8.5±0.3	10.3±1.5
4	Reducing sugar	20.6±0.8	4.2±0.2

Major Therapeutic Applications of *Ganoderma lucidum*

- **Anti-Mycotic Attributes:** This wild mushroom has cited and proved as a potent antifungal agent for the treatment of several diseases. It was observed that the isolation from *G. lucidum* i.e. Ganodermin has an inhibitory effect against *Botrytis cinerea*, *Fusarium oxysporum*, *Physalospora piricola*. In addition to this, it can also effectively control the growth of *Penicillium oxalium*, *Candida albicans*, *Aspergillus Niger*, *A. flavus*, *A. tamari* when used the purified extract (Batra 2013)^[1].
- **Anti-bacterial Attributes:** *Ganoderma spp.* is known to act against both gram positive and gram-negative bacteria. It was reported that the culture and methanolic extract of *G. lucidum* can substantially affect the growth of *Bacillus subtilis* (Batra *et al* 2013)^[1]. The water-soluble extract of this mushroom is known to inhibit 15 types of bacteria. In 2008, Keypour and the co-workers has proved the antibacterial effect against *E. coli*, *Pseudomonas aeruginosa*, *B. subtilis*, *Enterococcus*, *Staphylococcus aureus* etc *in vitro* condition.
- **Anti-viral Attributes:** Novel anti-viral agents can potentially affect the growth and multiplication of several viruses without any harm to other cells. Experiments have proved that the existence of various triterpenoids can effectively control the growth of viruses. Multiplication of Human immune deficiency virus type 1 (HIV-1) can be reduced by using the water extract of *G. lucidum* mushroom. Ganodermanontriol and Ganoderiol F are two antiviral agents isolated from the mushroom fruiting bodies.
- **Anti-cancer Attributes:** From long past, *Ganoderma lucidum* is known to treat several life-threatening diseases like cancer. The dried products of *G. lucidum* is found in market which is referred as a cancer chemotherapy agent and become popular throughout the world. Numerous bioactive agents mainly polysaccharides and triterpenes isolated from *Ganoderma spp.* is proved to contain tumour reducing and chemo preventing effects both *in vitro* and *in vivo* condition in animals and humans with very little proof on human trial.
- **Immunomodulating Agent:** *Ganoderma lucidum* is proved to modulate the immune system by increasing the resistance against several diseases. Previous studies have reported the mechanism of immunomodulation through enhancing immunological effectors and inducing the cytokines (Wang *et al* 1997; Zhu and Lin 2006)^[14, 15]. The polysaccharides present in *G. lucidum* can function as an immunomodulator both in laboratory as well as in open condition. The bioactive agents modulate the immune system by modifying the macrophages, stimulating cytokines, T and B lymphocytes, antigen producing cells etc. The target site for immunomodulating action is guessed to modify immune precursor cells to effector cells.

- **Antioxidant Activity:** The antioxidant rich diets can help humans to defence against severe life-threatening diseases. *G. lucidum* can used as an antioxidant from natural source. These nature derived antioxidants can absorb rapidly soon after incorporation in the body which helps in increasing the antioxidant activity of plasma (Wachtel-Galor *et al* 2005)^[12]. It was observed that *G. lucidum* can reduce the formation of free radicals and scavenging activities when it is extracted with chloroform and water mixture. The methanolic extract act as lipid peroxidation inhibitor and a scavenger of superoxide and hydroxy radical.
- **Hepatoprotective Attributes:** *G. lucidum* can function as an alternative for chemical medicines to protect the liver injury. Ganoderma acid A derived from this mushroom is referred as one of the most effective inhibitors on β -glucuronidase. Another study has concluded the hepatoprotection against mice when the hot water extract of this mushroom was injected orally. This can reduce the degradation of lipid peroxidases which can result the formation of malondialdehyde (Shieh *et al* 2001)^[11]. The methanol water mixture can as a hepatoprotector in rats when this extract was ingested orally to reduces the injury caused by benzo (a) pyrene (Lakshmi *et al* 2006)^[8].
- **Antiangiogenic Attributes:** The process of formation of new blood vessels from the existing ones are known as angiogenesis. This process can be a harmful one by forming dangerous tumour cells from the dormant one. An *in vivo* experiment has concluded that the mycelial extracts of *G. lucidum* with soybean extract. i.e. genistein combined polysaccharide can hinder the angiogenesis process (Miura *et al* 2002)^[9]. Anti-angiogenic attributes were also found from *G. lucidum* polysaccharides peptide (GLPP) and its serum.
- **Antidiabetic Attributes:** Potential hypolipidemic and hypoglycaemic activities were found from *G. lucidum*. A research conducted by Seto and his co-workers proved the antidiabetic level when hot water extract of *G. lucidum* was ingested orally in mice. It was observed the reduction of blood sugar level within 24 hours of ingestion while no effect on insulin level. The polysaccharides of *G. lucidum* i.e. Ganoderan A and B is found to have anti-diabetic property in mice. As more researches were conducted on animals, still human trials can give more evidence on it.
- **Anti-Aging Attributes:** Anti-aging agents are in high demand in cosmetic industries now-a-days. *G. lucidum* can be referred as an anti-oxidant agent considering its effect against cancer, diabetics, atherosclerosis, androgenic activities such as acne, hirsutism, androgenic alopecia etc. This mushroom also contains vitamins, chemo protective agents which can defence against some diseases. GA-B, -C2, -G of this mushroom have anti-aging effect as mentioned by Guesnet and his so workers in 2003.

Future Scope and Conclusion

Now-a-days people are preferring drugs from natural source, less chemical additives added and most important without any side effects. *Ganoderma lucidum* is playing a major role in drug and medicinal industries for its fast action and effective against multiple diseases. It can also use as an immunomodulator before and after any type of medical surgery. Regardless of all the benefits, evidence and

knowledge on many corners of this wild wonder herb is still unknown. More researches should be carried on focusing the isolation of more bioactive molecules and biometabolites by using biotechnological tools. More focus on its characteristic and growth parameters is needed to be explored through several studies. The exploration of the use of nanoparticle-based drug delivery system can be an amazing discovery in near future. More commercialization of this product is yet to be achieved in upcoming days as it lacks the production of bulk amount in present days. The studies conducted till today are *in vitro* and *in vivo*, clinical trials are still needed.

The wide application of *G. lucidum* to fight against various life-threatening diseases is well known. The anti-microbial, anti-diabetic, anti-aging, immune modulating, anti-diabetic properties etc has proved it as an amazing wonder herb. This Well-known Asian herb not only rich in therapeutic properties but also carry vitamins and minerals. It has gained great interest by the scientists to discover more novel drugs against important diseases. Different formulations are available in market in different forms such as powdered form, supplementary diet, creams, capsules, syrups etc. But mass production of these products has not yet met the demand. These products and its wide health benefits are still unaware by many peoples. Therefore, govt. organizations, NGOs, drug companies should take steps to reach this product among all peoples. This wonder herb can take a major place in pharmaceutical industries if novel bioactive compounds explored and the drugs should carry all the therapeutic properties from farm to market without any loss of any medicinal attributes during processing which will help the mankind against many diseases.

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