# CHAPTER 3 MEDICINALLY IMPORTANT MUSHROOMS

*Synopsis*

Many edible and non-edible mushrooms have long been used worldwide, especially in the Orient, for medicinal purposes. This Chapter gives a brief summary of the most important and widely used species. In each case their historical and current traditional use is considered together, where appropriate, with their commercial and modern medical applications. Important pharmaceutical products with proven medical applications have been derived from *Ganoderma* spp., *Lentinus edodes, Schizophyllum commune, Tremella fusiformis, Trametes versicolor*, and *Grifola frondosa,* and more recently *Phellinus* and *Hericium erinaceus*.

In addition to their nutritional value, many edible large mushrooms have long been used in the Orient for medicinal purposes. Many non-edible species have also gained important medicinal usage. An old Chinese proverb states that “medicine and food have a common origin”. At present there are at least 270 species of mushroom that are known to have various therapeutic properties (Ying *et al*., 1987). The practice of using fungi, especially mushrooms, in Chinese herbal medicines has been recorded in early records of the “Materia Medica”. The earliest book on medicinal materials in China, the “Shen Noug’s Herbel” (Shen Noug Pen Ts’ao Jing) (100-200AD), recorded the medicinal effects of several mushrooms including *Ganoderma lucidum, Poria cocos, Tremella fuciformis* and others. The most outstanding work on traditional Chinese medicines “Pen Ts’ao Kang Mu” (Compendium of Materia Medica) compiled by Li Shi-Zhen of the Ming Dynasty and published in 1575 documented more than 20 mushroom species, together with a non-mushroom insect-infesting fungus *Cordyceps senensis* which continues to be a major Chinese medicinal fungus (Bensky and Gamble, 1993).

Medicinal mushrooms have become even more widely used as traditional medicinal ingredients for the treatment of various diseases and related health problems largely due to the increased ability to produce the mushrooms by artificial methods. As a result of large numbers of scientific studies on medicinal mushrooms especially in Japan, China and Korea, over the past three decades, many of the traditional uses have been confirmed and new applications developed (Table 1, Wasser and Weis, 1999a). While much attention has been drawn to various immunological and anti-cancer properties of these mushrooms they also offer other potentially important therapeutic properties including antioxidants, anti-hypertensive, cholesterol-lowering, liver protection, anti-fibrotic, anti-inflammatory, anti-diabetic, anti-viral and anti-microbial. These properties will be examined in a later chapter. Clearly, many pharmaceutical companies in the Far East are viewing the medicinal mushrooms as a rich source of innovative biomedical molecules. Many polysaccharide-bound proteins produced by Basidiomycete fungi have been classified as anti-tumour chemicals by the US National Cancer Institute (Jong and Donovick, 1989). Some of the more important and leading medicinal fungi used in the Far East will be briefly summarised. For fuller details of each medicinal mushroom reference should be made to Hobbs (1995), Stamets (1993, 2001) and Mizuno (1995). A recent general paper by Wasser and Weis (1999b) gives detailed general mycological information on several of the most important medicinally valuable Basidiomycetes mushrooms, including biological and ethnomycological properties, taxonomy, morphology, anatomy, description, cultural characteristics, and distributions.

**TABLE 1 Cross index of medically active higher Basidiomycetes mushrooms and their medicinal properties** (Wasser and Weis, 1999a)

| 1 | 2 Antifungal | 3 Antiinflammatory | 4 Antitumour | 5 Antiviral (e.g. anti-HIV) | 6 Antibacterial & Antiparasitic | 7 Blood pressure regulation | 8 Cardiovascular disorders | 9 Hypercholesterolemia, hyperlipidemia | 10 Antidiabetic | 11 Immunomodulating | 12 Kidney tonic | 13 Hepatoprotective | 14 Nerve tonic | 15 Sexual potentiator | 16 Chronic bronchitis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Auriculariales** | | | + | | | + | X | X | | | | | | | X |
| *Auricularia auricula-judas* (Bull.) Wettst. | | | | | | | | | | | | | | | |
| **Tremellales** | | + | + | | | | | + | + | + | | + | | | X |
| *Tremella fuciformis* Berk. | | | | | | + | | | | | | | | | + |
| *Tremella mesenterica* Rits.:Fr. | | | | | | | | | | | | | | | |
| **Polyporales** | | | | | | | | | | | | | | | |
| *Schizophyllum commune* Fr.:Fr. | | X | X | | X | | | | | X | X | X | | | |
| *Dendropolyporus umbellatus* (Pers.:Fr.) | | | X | | | | | | | X | | X | | | X |
| Jül. | + | | X | X | X | X | | | X | X | | + | | | + |
| *Grifola frondosa* (Dicks.:Fr.) S.F. Gray | | | | | | | | | | | | | | | |
| *Fomes formentarius* (L.:Fr.) Fr. | | | + | | + | | | | | | | | | | |
| *Fomitopsis pimicola* (Schw.:Fr.) P. Karst. | | + | + | | + | | | | | | | + | | | |
| *Trametes versicolor* (L.:Fr.) Lloyd | | | X | X | X | | | | | | X | X | | | |
| *Piptoporus betulinus* (bull.:Fr.) P. Karst. | + | | + | | + | | | | | | | | | | |
| *Hericium erinaceus* (bull.:Fr.) Pers. | | | + | | | | | | | X | | | X | | X |
| *Inonotus obliquus* (Pers.:Fr.) Bond.et Sing. | | X | X | | | | | | | X | | X | | | |
| *Lenzites betulina* (L.:Fr.) Fr. | | | + | | | | + | | | | | | | | |
| *Laetiporus sulphurous* (Bull.:Fr.) Murr. | + | | + | | | | | | | | | | | | |
| **Ganodermatales** | | | | | | | | | | | | | | | |
| *Ganoderma lucidum* (Curt.:Fr.) P.Karst | | X | X | X | X | X | X | | | X | X | X | X | X | X |
| *Ganoderma applanatum* (Pers.) Pat. | | | + | + | + | | | | | + | | | | | |
| **Agaricomycetideae** | | | | | | | | | | | | | | | |
| **Agaricales s.l.** | | | | | | | | | | | | | | | |
| **Pleurotaceae** | | | | | | | | | | | | | | | |
| *Lentinus edodes* (Berk.) Sing. | | X | X | X | X | X | | X | X | X | X | X | | X | |
| *Pleurotus ostreatus* (Jacq.:Fr.) Kumm. | | | + | + | + | | | + | | | | | + | | |
| *Pleurotus pulmonarius* (Fr.:Fr.) Quél | + | | + | | | | | + | | | | | | | |
| **Tricholomataceae** | | | | | | | | | | | | | | | |
| *Flammulina velutipes* (Curt.:Fr.) P.Karst. | + | X | X | + | | | | | | X | | | | | |
| *Oudemansiella mucida* (Schrad.:Fr.) v. Höhn. | X | | | | | | | | | | | | | | |
| *Armillariella mellea* (Vahl.:Fr.) P.Karst. | + | | | | | X | X | | | | | | X | | |
| *Hypsizygus marmoreus* (Peck) Bigel. | | | X | | | | | | | | | | | | |
| *Marasmius androsaceus* (L.:Fr.) Fr. | | X | | | | | | | | | | | X | | |
| **Agaricaceae** | | | | | | | | | | | | | | | |
| *Agaricus bla\ei* Murr. | | | X | | | | | | | | | | | | |
| *Agaricus bisporus* (J.Lge) Imbach | | | + | | | | | | | X | X | | | | |
| **Pluteaceae** | | | | | | | | | | | | | | | |
| *Volvariella volvacea* (Bull.:Fr.) Sing. | | | + | + | + | | | + | | | | | | | |
| **Bolbitiaceae** | | | | | | | | | | | | | | | |
| *Agrocybe aegerita* (Brit.) Sing. | + | | + | | | | | + | | | | | + | | |

X = commercially developed mushroom product (drug or dietary supplement)

\+ = non commercially developed mushroom product.

## *Ganoderma lucidum and Ganoderma tsugae:*

*G. lucidum* and related species have the longest historical usage for medicinal purposes, dating back at least four millennia (Zhao and Zeuny, 1994). In Japan it is called *Reishi* or *Mannetake* (10,000 year mushroom) and in China and Korea it is variously called *Ling Chu, Ling Chih* and *Ling Zhi* (Mushroom of Immortality). It is the mushroom most depicted in ancient Japanese, Korean and Chinese Art and has been extensively depicted in Chinese royal tapestries. Reishi is also widely used in the Orient as a talisman to protect a person or home against evil. The fungus grows in many parts of the world and in Japan is to be found mainly on old plum trees. Originally, rare and expensive it can now be artificially cultivated, which makes it more accessible and affordable.

The mushroom and mycelium contain steroids, lactones, alkaloids, polyssacharides and triterpenes. Pharmacologically, a number of the water-soluble polysaccharides have demonstrated antitumour and immunostimulating activities. At least 100 different alcohol-soluble triterpenes have been identified including highly oxidised lanostane-type triterpenoids such as ganoderic, ganoderenic, lucidenic, and ganolucidic acids. These triterpenoids have been shown to possess adaptogenic and antihypertensive as well as anti-allergic properties.

**Fig. 1a *Ganoderma lucidum* growing naturally on tree stump**

**Fig. 1b Reishi motif on pavilion door in the Forbidden City, Beijing (**Willard 1990**)**

**Fig. 1c Contemporary Chinese painting depicting the Phoenix bird holding a Reishi mushroom: both Ancient Chinese symbols of longevity** (Willard, 1990)

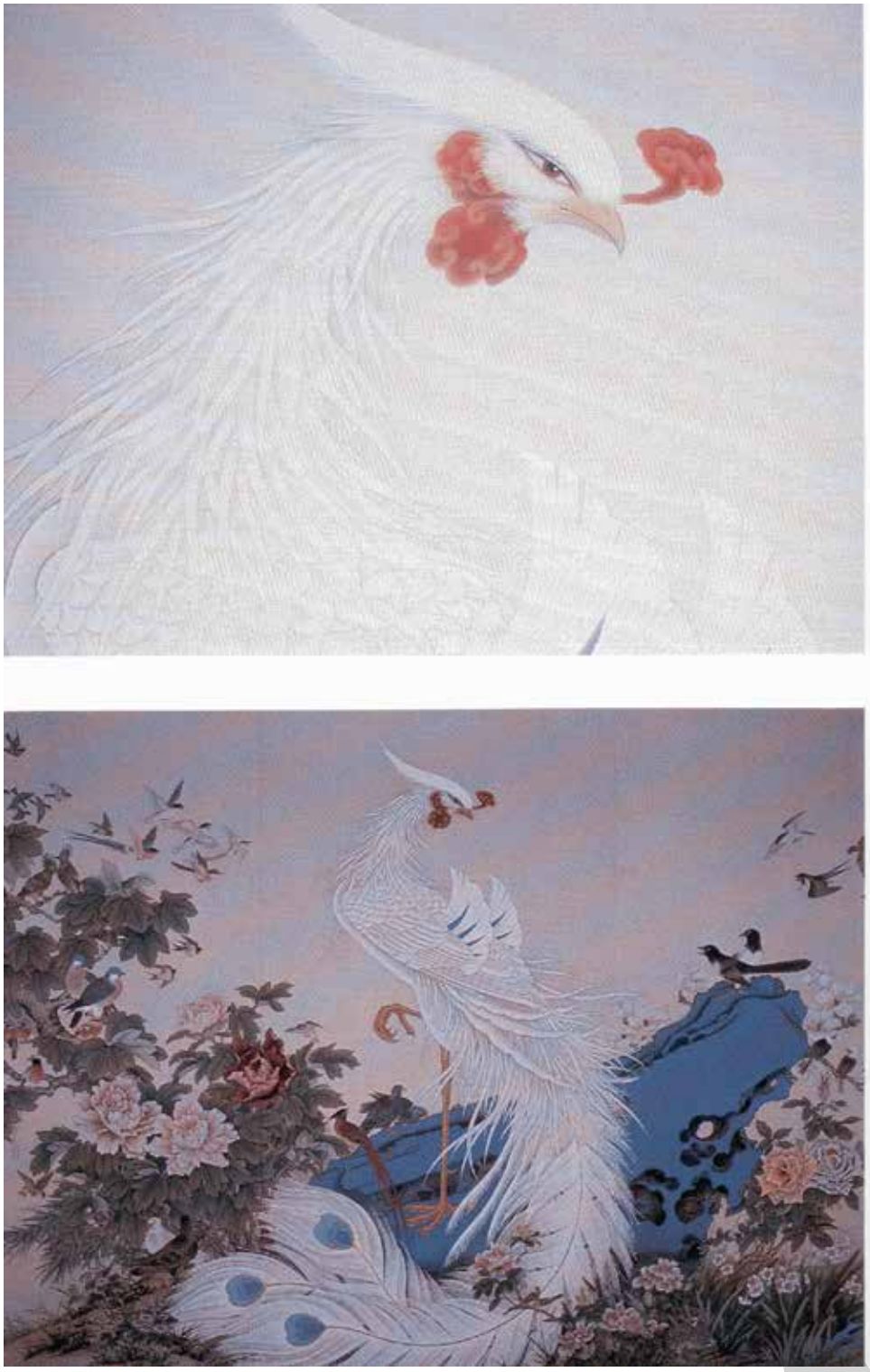

**Fig 1d *G. tsugae*, antler form growing on sterilised sawdust media** (Willard, 1990**)**

**Fig. 1e *G. lucidum* growing on sterilised sawdust media** (Willard, 1990)

This mushroom possesses many different medicinal properties dependent on the stage and environment of its growth (Jong and Birmingham, 1992, Liu, 1999). Traditionally, it has been widely used in the treatment of hepatopathy, chronic hepatitis, nephritis, hypertension, arthritis, neurastheine, insomnia, bronchitis, asthma and gastric ulcers. Scientific studies have confirmed that substances extracted from the mushroom can reduce blood pressure, blood cholesterol and blood sugar levels as well as inhibit platelet aggregations (Table 2). Reishi extracts have been highly effective in alleviating altitude sickness and also in treating myotonia dystrophica. Several major biochemicals such as polysaccharides, proteins and triterpenoids with potent immuno-modulating action have been isolated from *Ganoderma* spp. The major immuno-modulating effects of these active substances include mitogenicity and activation of immune effector cells such as T cells, macrophages and natural killer cells resulting in the production of cytokines, including interleukins, tumour necrosis factor-α and interferons. The therapeutic action of *G. lucidum* as an anti-cancer and anti-inflammatory agent has been associated with its immuno-modulating properties (Wang *et al*., 1977). While the extensive range of traditional medical treatments with this mushroom have not yet been fully substantiated by modern scientific standards they are being extensively scrutinised in the Far East and the USA (Chang, 1995, 1999, Chen and Miles, 1996). In view of its bitter taste and indigestible structure (often similar to varnished wood in appearance) this is not an edible mushroom but, in hot water extracted form, it is available worldwide in tablet and liquid products (Stamets, 1999).

**Table 2 Pharmacological effects of whole Reishi extracts *in vivo* and *in vitro*** (for references see Hobbs, 1995)

| |
|---|
| • Analgesic |
| • Anti-allergic activity |
| • Bronchitis-preventative effect, inducing regeneration of bronchial epithelium |
| • Anti-inflammatory |
| • Antibacterial, against *Staphylococci, Streptococci,* and *Bacillus pneumoniae* (perhaps due to increased immune system activity) |
| • Antioxidant, by eliminating hydroxyl free radicals |
| • Antitumor activity |
| • Antiviral effect, by inducing interferon production |
| • Lowers blood pressure |
| • Enhances bone marrow nucleated cell proliferation |
| • Cardiotonic action, lowering serum cholesterol levels with no effect on triglycerides, enhancing myocardial metabolism of hypoxic animals, and improving coronary artery hemodynamics |
| • Central depressant and peripheral anticholinergic actions on the autonomic nervous sytem reduce the effects of caffeine and relax muscles |
| • Enhanced natural killer cell (NK) activity *in vitro* in mice |
| • Expectorant and antitussive properties demonstrated in mice studies |
| • General immunopotentiation |
| • Anti-HIV activity *in vitro* and *in vivo* |
| • Improved adrenocortical function |
| • Increased production of Interleukin-1 by murine peritoneal macrophages *in vitro* |
| • Increased production of Interleukin-2 by murine splenocytes *in vitro* |

*Key active constituents*:
Beta and hetero-Beta-glucans (antitumour, immunostimulating )
Ling Zhi-8 protein (anti-allergenic, immuno-modulating)
Ganodermic acids – triterpenes (anti-allergenic agents, cholesterol and blood pressure reducing)

Estimates place the annual value of *G. lucidum* products worldwide at more than US $ 1.6 billion (Chang and Buswell, 1999).

## *Lentinus edodes*

This fungus is indigenous to Japan, China and other Asian countries with temperate climates. It is to be found in the wild on fallen deciduous trees especially

**Fig. 2a *Lentinus edodes* growing naturally on fallen timber**

**Fig. 2b *L. edodes* fruiting on an oak log** (Stametes 1993)