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Medicinal mushrooms native to Slovenia

Zdravilne gobe rastoče v Sloveniji

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Abstract: Slovenia with its diverse environment is home to more than 2400 fungal species out of which especially many macromycetes have for millennia been used worldwide as natural remedies. These species of mushrooms were in the past picked from the nature, but today can be cultivated as fruiting bodies or fungal biomass on different substrates. They possess immunomodulating, antiviral, antibacterial and anticancer activities and can be used against allergies, dementia, Alzheimer disease and in many other diseases. They represent a vast potential as natural remedies with no or very little adverse effects and can be processed into food supplement or further developed into medicines. These mushrooms are a natural treasure, which enables us to be more self-sufficient if we cultivate them for medical and certain species for nutritional purposes as well.

Keywords: medicinal mushrooms, Slovenia, polysaccharides, cancer, natural remedies, endangered fungi

Povzetek: Slovenija s svojim raznovrstnim okoljem je dom več kot 2400 različnim vrstam gliv, izmed katerih se mnogo makromicet globalno uporablja v obliki naravnih zdravil. Te vrste so v preteklosti nabirali v naravi, danes pa jih lahko gojimo v umetnih pogojih, na različnih substratih, kot glivno biomaso ali trosnjake. Pripisujejo jim sposobnosti krepitve imunskega sistema, delovanje proti rakavim obolenjem, virusom, bakterijam, Alzheimerjevi bolezni, alergijam, demenci in še veliko drugim boleznim. Predstavljajo ogromen potencial kot naravna zdravila brez ali le z zanemarljivimi nezaželenimi stranskimi učinki in jih je mogoče predelati v prehrnaska dopolnila ali celo zdravila. Te gobe so naravno bogastvo, ki nam omogoča večjo samopreskrbo, če jih gojimo za medicinske, nekatere pa tudi za prehranske namene.

Ključne besede: zdravilne gobe, medicinske gobe, Slovenija, polisaharidi, rak, naravna zdravila, ogrožene glive

Introduction

For millennia mushrooms have been used not just for food, but also for other purposes, among which medicinal use was one the most prominent (Wasser et al. 2000). Although mushroom cultivation techniques were mastered in the last few decades, while in the past their use was dependent mostly on natural habitats and growing seasons. Nowadays cultivation techniques for many mushroom species are used in large-scale cultivation facilities and many of these cultivated species are

available on the market not just as food, but also as food supplements and medicines. Wild species, which were commonly used in the past, are now often neglected because of artificial cultivation. Some of the most interesting species are cultivated in liquid and solid media and their biomass is used in food supplement or even medicine production. The annual market of medicinal mushrooms and their derivative dietary supplements worldwide was estimated at 1.2 billion USD in 1991 (Chang 1996) and 6 billion USD in 1999 (Wasser et al. 2000) and is still growing. According to studies conducted so far, medicinal mushrooms have a very long tradition in Asian countries, whereas their use in the Western hemisphere has been slightly increasing only in the last decades (Lindequist et al. 2005). Many scientific research articles are proving their medicinal actions and potential use as natural medicines also in the Western hemisphere.

In Slovenia the use of medicinal mushrooms was not very common in the past and not a lot of information was available on this topic. Since the past decades research in the field of medicinal mushrooms is progressing in Slovenia, with research groups focusing on medicinal properties and different cultivation techniques of mushrooms. Recently, more than 2400 fungal species have been recorded in Slovenia (Jurc et al. 2005), not including lichen-forming fungi. Many of these species, especially saprophytic ones, possess different medicinal properties with majority of them still in need of identification.

The most important and most widely recognised medicinal mushrooms growing in Slovenia are *Ganoderma lucidum, Cordyceps militaris, Trametes versicolor, Grifola frondosa, Hericium erinaceus, Auricularia auricula, Fomes fomentarius, Fomitopsis pinicola, Piptoporus betulinus, Laricifomes officinalis, Pleurotus ostreatus* and *Schizophylum commune* with their distribution, traditional use and medicinal properties presented in this article (Vrhovec 2010).

Ganoderma lucidum (Curtis) P. Karst. (1881) (Ganodermataceae, Polyporales, Agaricomycetes, Agaricomycotina, Basidiomycota)

In Slovenia *G. lucidum* is an endangered and protected species, growing on broadleaf tree stumps, with 50 locations reported through the whole area of Slovenia (Ogris 2013). Wild growing fruiting bodies are very small in comparison to specimens cultivated on artificial sawdust-based substrates, and because of that a very poor substitute for cultivated mushrooms. Still many people pick them in nature even further endangering its natural habitats.

In the last few years this species is becoming popular in Slovenia as a food supplement. *G. lucidum* food supplements users mostly report its chemotherapy side-effects reducing, anti-allergic, immune system enhancing, anti-viral, anti-bacterial and stress reducing properties.

G. lucidum is a popular medicinal mushroom, considered inedible due to its toughness and bitterness. Traditionally it was used in Japan and China to treat nephritis, chronic hepatitis, hepatopathy, gastric ulcers, asthma, bronchitis, insomnia and arthritis (Jong et. al. 1992, Hobbs 1995, Chang and Buswell 1999, McKenna et al. 2002). *G. lucidum* contains more than 400 bioactive substances from the groups of polysaccharides, triterpenes, sterols, nucleosides, fatty acids and proteins (Mizuno 1995, Kim and Kim 1999, McKenna 2002, Gao et al. 2002, Boh 2013) from which polysaccharides and triterpenes have been researched the most. Polysaccharides comprise one of the major sources of pharmacologically active compounds in *G. lucidum*. It contains more than 100 types of polysaccharides (Wasser 2005) showing strong immunomodulating activities. The major immunomodulating effects include mitogenecity and activation of immune effector cells such as T lymphocytes, macrophages and NK cells, leading to the production of cytokines including interleukins, tumor necrosis factor alpha and interferons (Zhou et. al. 2002a). *G. lucidum* contains more than 140 triterpenes (Yue et. al. 2010), which inhibit histamine release, viral induction and cholesterol synthesis and show hepatoprotective, anti-hypertensive, anti-inflammatory, apoptosis

inducing, antioxidative, anti-tumour, anti-microbial and immunomodulating activity (Boh et al. 2007, Powell 2010). Tyrosinase contained in *G. lucidum* fruiting bodies shows genoprotective effects (Shi et al. 2002). Jin and coworkers (2012) published an up to date review on *Ganoderma lucidum* and its clinical studies on cancer patients.

Cordyceps militaris (L.) Link (1833 (Cordycipitaceae, Hypocreales, Hypocreomycetidae, Sordariomycetes, Pezizomycotina, Ascomycota)

C. militaris grows mostly in the north-western and central part of central Slovenia with 13 locations reported (Ogris 2013). This year new locations were found near the city of Bled, where fruiting bodies start to emerge from the soil on the pastures in the late October. *C. militaris* is not traditionally used in Slovenia as a medicinal mushroom. Its dry fruiting bodies are much smaller in size and weight and are not abundant enough to be picked for consumption. Some native *C. militaris* strains are cultivated in Slovenia by Slovenian companies and used as high-quality food supplements.

Cordyceps ascocarp originates at its base, on an insect larval host and ends in a club-like cap, including the stipe and stroma. There are more than 700 species of *Cordyceps* identified worldwide (Powell 2010) out of which only two (*C. sinensis* and *C. militaris*) are used in medicinal practice on a large scale. In nature these species grow as parasites on moth larvae (Kirk et al. 2001). The wild form of *Cordyceps sinensis* has always been one of the most expensive medicinal "herbs" and in ancient China was in the past reserved almost exclusively to members of the Emperor's court (Holliday et al. 2005). In 2006 the price for one kg was 12.000 USD (Paterson 2008) and has nearly doubled in the last few years, but the demand is still growing due to pharmacologically active substances contained in this fungus, attracting broad public interest.

In 2000 Wu and his coworkers found out that only *C. militaris*, producing cordycepin (3′-deoxyadenosine), has similar pharmacological activity to *C. sinensis*, whose biological characteristics were studied early in the 1950s. *C. militaris* was used traditionally as a natural medicine and for treating cancer (Ng and Wang 2005). Cordycepin is considered as a main bioactive metabolite of *C. militaris* (Hung et al. 2009) and is reported to exhibit anti-viral, anti-tumor, anti-fungal, anti-bacterial, anti-leucemic activities as well as anti-metastatic action and prevention of alcohol-induced hepatotoxicity (Koc et al. 1996, Kim et al. 2002, Zhou et al. 2002b, Nakamura et al. 2006, Lee et al. 2013, Cha et al. 2013).

Pleurotus ostreatus (Jacq.) Quél. (1871) (Pleurotaceae, Agaricales, Agaricomycetidae, Agaricomycetes, Agaricomycotina, Basidiomycota)

Pleurotus ostreatus is one of the most popular cultivated edible mushroom species, which in 1997 accounted for 14.2% of the world total edible mushroom production (Chang 1999). Mostly it is cultivated on pasteurized straw, stumps or logs (Pavlik and Pavlik 2013) and in Asia also on supplemented sawdust (Gregori et al. 2007b). It can also be cultivated on different agricultural leftovers (spent brewery grains, oil press cakes, bran, corn cobs, seed hulls etc.) (Gregori et al. 2007b). Its cultivation on logs and stumps is considered as very easy and is widespread between amateur growers around the world.

In Slovenia this species can be found on broad-leaf trees late in autumn. It is not well recognized by the broad public as edible and not at all recognized as medicinal. There are 81 locations of *P. ostreatus* reported in Slovenia (Ogris 2013).

P. ostreatus is mostly mentioned as an edible mushroom, but besides its gastronomic properties it also contains bioactive substances, especially polysaccharides, which show immunomodulating (Bauerova et al. 2009) as well as LDL lowering and blood lipid levels improving properties (Bobek et al. 1991, Bobek et al. 1997, Opletal et al. 1997, Gunde-Cimerman et al. 2001, Hossain et al. 2003). Polysaccharides from *P. ostreatus* show anti-cancer and hepatoprotective activities and increase activity of superoxide dismutase, catalase and counter the age related reduction in levels of vitamins C and E (Kurashige et al. 1997, Gu and

Sivam 2006, Jayakumar et al. 2006, Jayakumar et al. 2007, Thanasekaran et al. 2010).

Trametes versicolor (L.) Lloyd (1921) (Polyporaceae, Polyporales, Agaricomycetes, Agaricomycotina, Basidiomycota)

T. versicolor is one of the most researched medicinal mushrooms (Powell 2010) and an abundant species in Slovenia with 151 locations reported (Ogris 2013). Usually thousands can be found everywhere where wood debris is present. It grows on all types of dead wood, but prefers broadleaf trees. Sporocarps form mainly in the late autumn and early spring, when snow starts to melt providing moisture to the emerging fruiting bodies. Gathering of *T. versicolor* is not very common in Slovenia, but is becoming more and more popular as a natural way of treating different health issues. People use it for the preparation of tea and tinctures for immune system enhancement (Vrhovec 2010). Because of its wide distribution and abundant quantities in Slovenia, we can consider this species as a medicinal mushroom with a big potential in natural disease treatment, especially for people with low income. Its gathering presents almost no danger of misidentification with other species.

In China and Japan they developed two medicines (PSP and PSK), composed of *T. versicolor* water-soluble polysaccharopeptides, and with many clinical trials performed. It was shown that PSP and PSK are very effective in the treatment of different cancer types including gastric, lung, nasopharyngeal, colorectal, breast, oesophageal as well as uterine cancer (Tsukagoshi et al. 1984, Ng 1998, Parris 2000, Fisher and Yang 2002, Cui and Chisti 2003, Kanazawa et al. 2005, Jimenez-Medina et al. 2008, Standish et al. 2008). *T. versicolor* also shows strong anti-viral activities proven *in vitro* (Hirose et al. 1987, Tochikura et al. 1987, Hobbs 2004, Mlinaric et al. 2005, Ng et al. 2006) and also on HIV patients (Pfeiffer 2001). *T. versicolor* polysaccharides and polysaccharopeptides besides anti-cancer possess also immune system enhancing activities (Tzianabos 2000, Standish et al. 2008).

Hericium erinaceus (Bull.) Pers. (1797) (Hericiaceae, Russulales, Agaricomycetes, Agaricomycotina, Basidiomycota)

H. erinaceus is a well-known edible medicinal mushroom, with a distinct shape, which resembles a beard or a monkey's head. It grows on dead broadleaf trees and some species from this genus (*H. abietis*) also on pine trees. There are 18 locations of *H. erinaceus* reported in Slovenia mostly in the central, northeast and southwestern part of the country (Ogris 2013). In Slovenia *H. erinaceus* is a very rare, endangered and protected species and the knowledge about its use is not known to the broader public. In the last few years it is gathering on reputation due to the products on the market produced through artificial cultivation of fruiting bodies and biomass.

In Asia they also call it "a Natures nutrient for neurons", because it contains erinacines, which stimulate the biosynthesis of the nerve growth factor and catecholamines in the central nervous system (Kenmoku et al. 2002, Shimbo et al. 2005, Mori et al. 2008, Kawagishi et al. 2011). This species shows a good potential for treating Alzheimer's disease, dementia, multiple sclerosis and even physical damages of nerves (Kolotushkina et al. 2003, Mori et al. 2009). It has been demonstrated by several studies over the last 2–3 decades that *H. erinaceus* possesses anticancer activities, strongly linked to immunomodulation (Liu et al. 2000, Lee and Hong 2010, Khan et al. 2013), acts against methicillin-resistant *Staphylococcus aureus* (Kawagishi 2005) and even gastritis caused by *Helicobacter pylori* (Xu et al. 1985, Yu et al. 1999) or ethanol ingestion (Abdulla et al. 2009).

Grifola frondosa (Dicks.) Gray (1821) (Meripilaceae, Polyporales, Agaricomycetes, Agaricomycotina, Basidiomycota)

G. frondosa usually grows on stumps or the base of hardwood trees like oak and weights up to ten kilograms (Rogers 2011). There are 44 locations reported in Slovenia (Ogris 2013). It is considered

as an endangered and protected species, not often used in culinary or medicinal purposes.

G. frondosa is one of the tastiest polypores, similar to eggplant in flavor (Rogers 2011). It contains polysaccharides, which are the major active components. Several beta-glucan, heteropolysaccharide and proteoglycan fractions have been isolated with potent immunomodulatory action, including D-fraction and MD-fraction (Powell 2010). The D-fraction, the MD-fraction, and other extracts, often in combination with whole *G. frondosa* fruiting bodies powder, have shown particular promise as immunomodulating agents and as an adjunct to cancer and HIV therapy (Kodama et al. 2002, Kodama et al. 2003). They may also provide some benefit in the treatment of hyperlipidemia, hypertension, and hepatitis (Mayell 2001). Antidiabetic and cholesterol action has also been reported for fruiting bodies and extracts of *G. frondosa* (Kubo et al. 1994, Kubo and Nanba 1997).

Schizophyllum commune Fr. (1815 (Schizophyllaceae, Agaricales, Agaricomycetidae, Agaricomycetes, Agaricomycotina, Basidiomycota)

113 locations of this species are officially reported in Slovenia (Ogris 2013), but in general is more widespread on logs, branches and stumps of broadleaf and coniferous trees, especially poplar, birch, spruce and pine (Evans and Kibby 2005, Rogers 2011). In Thailand it is used as a gourmet mushroom, prepared in dishes as are fried eggs or fried rice. This species was also found growing in hay bales (Webster 1991). In Slovenia the broader public because of lack of information does not yet use it. There are some reports of its use as a tea (Vrhovec 2010), but they are very rare.

S. commune contains polysaccharides with schizophyllan, having a molecular weight of 450 kD, being the most researched. It was shown to inhibit solid Sarcoma 180 tumor (Komatsu et al. 1969), prolongs survival and time to recurrence in stage II cervical cancer patients (Okamura et al. 1989, Miyazaki et al. 1995). Salahuddin (2008) tested different *S. commune* extracts and determined that they show a broad spectrum of antimicrobial, antioxidant, cytotoxicity and anti-human papilloma virus activities. In traditional Chinese medicine this fungus is recommended for general weakness and debility (Rogers 2011). It is recommended to cook the fruiting bodies before usage otherwise the fungus can spread inside the living healthy tissue of humans as well as animals (Kano et al. 2002, Rogers 2011).

Auricularia auricula (L.) Underw. (1902) (Auriculariaceae, Auriculariales, Agaricomycetes, Agaricomycotina, Basidiomycota)

There are 69 locations of this species officially reported in Slovenia (Ogris 2013). In Slovenia it grows almost exclusively on dead elder (*Sambucus nigra*) branches late in autumn. Pohleven (2010) reports on its use in Europe during the Middle Ages, when a saying was used "Auricularia put on the eye, removes all the pain". As people get to know this species and its culinary and medicinal use, they start picking and using it although traditionally it is not well known and used in Slovenia.

A. auricula is a very popular mushroom in traditional Chinese medicine and especially in traditional Chinese cuisine. Cultivation of this species is very popular in Asia and *A. auricula* is frequently mentioned as the first mushroom species to be cultivated in 600 A.D. (Chang and Miles 1987).

Ying (1987) reported of *A. auricula* being activitve against Ehrlich carcinoma and Sarcoma 180. In experiments conducted by Chen et al. (2008a) and by Zeng et al. (2013) polysaccharides extracted from *A. auricula* significantly decreased the levels of total cholesterol, triglyceride, and low-density lipoprotein cholesterol in hyperlipidemic mice and rats.

Fomes fomentarius (L.) J.J. Kickx (1867) (Polyporaceae, Polyporales, Agaricomycetes, Agaricomycotina, Basidiomycota)

This species grows on dead hardwood trees, in Slovenia more frequently on beech (*Fagus silvatica*) trees. *F. fomentarius* is very popular

in Slovenian tradition as an ornamental item and also for other uses. Dried fruiting bodies are lit by beekeepers and smoke is used for its sedative-like action it has on the bees. In Slovenia it is used for transferring the blessed fire from churches into homes and using it as incense in religious rituals. The same ritual is known also in Siberian tribes and Ainu people in Japan (Rogers 2011). There are no records of use of this fungus for medicinal purposes in Slovenia, but because of its wide distribution through the whole area, especially the eastern parts of Slovenia (168 locations reported by Ogris, 2013), it could be more often used as a medicinal remedy or as a food supplement. This species can be cultivated on mixture of sawdust and supplements (Stamets 2005) as an alternative to wild-grown specimens.

F. fomentarius has been firstly mentioned by Hippocrates (460–377 B.C.) who mentioned its topical use for cauterizing wounds and for externally treating inflamed organs (Stamets 2005). Dissociated context of this fungus was found besides the famous Oetzi, more than 5000 years old iceman found in the Italian Alps and was supposedly used as a fire starter or as a natural medicine (Capasso 1998, Rogers 2011).

F. fomentarius shows antibacterial properties. Peintner et al. (1998), Stamets (2005) and Suay et al. (2000) reported of its activity against *Pseudomonas aeruginosa, Serratia marcescens, Staphylococcus aureus, Bacilus subtilis* and *Mycobacterium smegmatis*, a relative of the pathogenic *Mycobacterium tuberculosis.* Polysaccharides contained in *F. fomentarius* show activity against sarcoma 180 tumors in mice (Ito et al. 1976) and anticancer activity against human gastric cancer cells (Chen et al. 2008b). Using in vitro models Seniuk et al. (2011) established that glucan complexes from *F. fomentarius* completely depressed the growth of *Candida albicans,* had an antimicrobial effect on *H. pylori*, possessed simultaneously weak toxicity and high anti-HIV-1 activity in comparison with zidovudine (Retrovir) and concluded that due to the very low toxic properties on blood cells even in very high concentrations, these complexes may be used as a source of biopolymers for the creation of essentially new agents for wide applications in infectious pathology.

Fomitopsis pinicola (Sw.) P. Karst. (1881) (Fomitopsidaceae, Polyporales, Agaricomycetes, Agaricomycotina, Basidiomycota)

With 150 locations of *F. pinicola* reported in Slovenia this mushroom can be considered as an abundant and very common species. In Slovenia it most commonly inhabits dead spruce trees, but can be also found on poplar, beech, birch and other tree species. *F. pinicola* is in general considered as one of the most common polypores in the world (Rogers 2011). This author knows of no reports of its medicinal use in Slovenia.

Traditionally in Northern America this mushroom was used on wounds to stop bleeding, as a daily tonic to stop inflammation of the digestive tract, to increase general resistance and against headaches (Rogers 2011). Chemical compounds found in *F. pinicola* include steroids, sesquiterpenes, lanostane triterpenoids and triterpene glycosides (Haghi 2011). In Germany homeopathic remedies are prepared from *F. pinicola*, but without stated indications. Alkaline extracts from *F. pinicola* show anti-hyperglycemic effects in streptozotocin induced diabetes mellitus rats (Lee et al. 2008). Cheng et al. (2008) observed antiinflammation and antiangiogenic effects of *F. pinicola* ethanolic extract and polysaccharides.

Laricifomes officinalis (Vill.) Kotl. & Pouzar (1957) (Fomitopsidaceae, Polyporales, Agaricomycetes, Agaricomycotina, Basidiomycota)

In Slovenia *L. officinalis* is an endangered and protected species with only three locations reported by Ogris (2013) and nine additional locations reported by Dakskobler et al. (2011). Pietka (2004b) and Mukhin et al. (2005) reported that number of *L. officinalis* specimens is also decreasing in Poland and Russia. The fruiting bodies of Slovenian specimens grow on old, thick larch trees (*Larix decidua*) that often have a dry or broken top and grow between 1430 and 1790 meters above sea level (Dakskobler et al. 2011). There are many other locations of *L. officinalis*

in Slovenia, very carefully protected by mycologists, because its growth in nature is very slow, and because this species is very sought after due to its medicinal properties. Regardles of the fact that this species is endangered and protected in Slovenia, people still gather and sell it on the black market for around 90 USD per kg (Vrhovec 2010). They use it as a tea, for strengthening the immune system or by smoking as an ailment against bronchitis.

Before it was brought to the edge of extinction, *L. officinalis* was available in European pharmacies, as a purgative, anticancer agent, antipyretic and analgesic drug, as an abortive agent or to inhibit bleeding in disorders of the teeth, as an anti-swelling agent or a sedative and to cure disorders of the digestive system (cited in: Pietka 2004b). Stamets (2005) reported of activity against orthopox viruses, caused by *L. officinalis* extracts. There were successful attempts already conducted for artificial inoculation of larch trees with *L. officinalis* mycelia (Pietka and Grzywacz 2005, Gregori et al. 2007a) and even artificial cultivation of mycelia in laboratory conditions (Pietka 2004a). There are still a few *L. officinalis* products on the EU market.

Piptoporus betulinus (Bull.) P. Karst. (1881) (Fomitopsidaceae, Polyporales, Agaricomycetes, Agaricomycotina, Basidiomycota)

There are officially 144 locations of this species reported in Slovenia (Ogris 2013), but many other not reported locations also exist. It grows on dead or dying birch trees mostly in the eastern part of the country. In Slovenia this species is used as an immunomodulator for people as well as for domestic animals. For this purpose decoctions and teas are used with reported efficient immunomodulating activity.

This species was found beside the Oetzi, more than 5000 years old iceman found in the Italian Alps and was admittedly used against parasites *Trichuris trichuria* (Capasso 1998). In folk medicine this mushroom was used to stop bleeding (Stamets 2005) as an antiparasitic and antimicrobial agent in the treatment of wounds and for the treatment of rectal cancer and stomach diseases. Tea obtained from this mushroom has antibacterial, antifatiguing, immunoenhancing, and soothing properties (Lemieszek et al. 2009).

Lemieszek et al. (2009) also reported that *P. betulinus* fractions elicit anticancer effects attributed to decreased tumor cell proliferation, motility and the induction of morphological changes. Schlegel et al. (2000) isolated an antibiotic named piptamine from this species. Kanamoto et al. (2001) reported that betulinic acid derivatives, extracted from this specie show activity against HIV viruses. Stamets (2005) reports of *P. betulinus* extracts having activity against vaccinia and cowpox viruses. Six lanostane-type triterpene acids were isolated from the fruiting bodies of *Piptoporus betulinus* by Kamo et al. (2003) showing anti-inflammatory properties. Also Manez et al. (1997) reported that terpenoids from this species reduced dermal inflammations. Betulinic acid – a pentacyclic triterpene, isolated from *P. betulinus*, was identified as a melanoma–specific cytotoxic agent completely inhibiting human melanomas without toxicity (Pisha 1995).

Conclusions

Slovenia with its small but very diverse geography and environment is home to more than 2400 fungal species. Many of these species, especially macromycetes were in the past used as a natural medicine. The old knowledge about their use is very scarce in Slovenia, but is returning from other countries and scientific literature mentioning their medicinal activities.

Mushrooms of this kind represent very accessible natural medicines, with no or little side effects with a very low price. The fact that the majority of medicinal mushrooms are wood-inhabiting species, shows a big potential for Slovenia. More than 50% of its area is covered by forest and has a very active wood industry, with sawdust as the main byproduct.

Beside species mentioned above, many other species native to Slovenia also contain medicinal compounds and can be used for medicinal purposes: *Coprinus comatus, Laetiporus sulphureus*, *Ganoderma applanatum, Polyporus umbellatus, Agaricus sp., Phallus impudicus, Albatrellus confluens, Lepista inversa, Heterobasidion an-*

nosum, Pycnoporus cinnabarinus, Craterellus curnicopioides, Tremella mesenterica, Lactarius deliciosus, Flammulina velutipes, Sparassis crispa, Armillaria mellea, Trametes suaveolens, Innonotus obliquus, Agrocybe cylindracea and others.

Zaključek

Slovenija s svojim majhnim, a raznovrstnim okoljem, je dom več kot 2400 vrstam gliv. Veliko teh vrst, še posebno makromicete so v preteklosti uporabljali kot naravna zdravila. Staro znanje o njihovi uporabi je v Sloveniji zelo redko, vendar se vrača iz drugih držav ter znanstvene literature, ki dandanes vedno bolj posveča pozornost tem vrstam gob.

Te vrste gob predstavljajo lahko dostopna naravna zdravila, brez ali z zelo redkimi nezaželenimi stranskimi učinki ter zelo nizko ceno. Dejstvo, da večina zdravilnih gob raste na lesu, kaže na velik potencial, ki ga s svojo več kot 50 % prekritostjo z gozdom in razvito lesno industrijo premore Slovenija.

Poleg zgoraj omenjenih vrst zdravilnih gob tudi sledeče vrste vsebujejo zdravilne učinkovine ter so uporabne kot potencialna naravna zdravila: *Coprinus comatus, Laetiporus sulphureus*, *Ganoderma applanatum, Polyporus umbellatus, Agaricus sp., Phallus impudicus, Albatrellus confluens, Lepista inversa, Heterobasidion annosum, Pycnoporus cinnabarinus, Craterellus curnicopioides, Tremella mesenterica, Lactarius deliciosus, Flammulina velutipes, Sparassis crispa, Armillaria mellea, Trametes suaveolens, Innonotus obliquus, Agrocybe cylindracea* and others.

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