SHORT COMMUNICATION

Lignicolous fungi hydrodistilled extracts may represent a promising source of natural phenolics

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ABSTRACT

In vitro evaluation of total phenolic contents and antiradical activities of the lignicolous fungi Fomes fomentarius and Schizophyllum commune hydrodistilled extracts was the subject of this study. This preliminary screening included four free radical species evaluated by UV–vis (DPPH•, ABTS• and •NO) and EPR (Asc•), respectively. According to the experimental data obtained, both F. fomentarius and S. commune hydrodistilled extracts may be considered as promising sources of phenolic natural products (157 and 138 mg GAE/g d.e., respectively) and other bioactives showing good anti-DPPH (1.31 μg/mL) and anti-Asc (70.40%) radical activities, respectively, at in vitro conditions.

1. Introduction

Due to their enzymatic machineries, lignicolous fungi effectively degrade wood mass which primarily consists of lignin, a polymer phenolic compound (Schmidt 2006; Matavulj et al. 2013). Fomes fomentarius (L.:Fr.) (Polyporaceae), tinder fungus, is a woody perennial fungus which develops as a parasite or saprophyte on the beech (Fagus sylvatica L.) and other deciduous
species. It is a white root fungus, large in size which causes heart root of the wood (Větrovský et al. 2011). This genus is known to be a source of bioactive phenolics (He et al. 2003). In traditional Chinese medicine, among the rest, *F. fomentarius* has been used for the treatment of various inflammations and cancers (Chen et al. 2008). Some research studies have actually confirmed ethnomedicinal claims (Park et al. 2004; Seniuk et al. 2011). Its most important compounds with clinically beneficial activity are β glucans (Grienke et al. 2014) and phenolics (Heleno et al. 2015). *Schizophyllum commune* Fr.:Fr., split gill fungus, is probably the most widespread existing macroscopic fungus existing on every continent except Antarctica, where there is no wood to be used as a substrate (Matavulj et al. 2013). Though usually considered as a widely distributed basidiomycetous pathogen (Sigler et al. 1999), *S. commune* has actually been acknowledged for its medical importance (Han et al. 2005). As an edible species, *S. commune* is widely consumed in Mexico and elsewhere in the tropics (Ruán-Soto et al. 2006). It is also very popular among the Malay community in Malaysia, the country where *S. commune* has been cultivated for the last ten years (Han et al. 2005). Besides phenolics and some other compounds, this fungus produces the neutral extracellular polysaccharide schizophyllan which possesses potent bioactivities both in vitro and in vivo (Smith et al. 2002; Yim et al. 2009; Tripathi & Bhupendra 2013). Generally speaking, there is a growing interest for natural phenolics, both for their medicinal and nutritional properties (Barros et al. 2009). Hydrodistilled extracts of lignicolous fungi were not the subject of extensive chemical research so far, neither was their biological activity evaluated to a greater extent. That was the reason why the total phenolic (TP) contents and antiradical activities (DPPH•, ABTS•, •NO and Asc•) of the hydrodistilled extracts of these fungi were tested (Green et al. 1982; Singleton et al. 1999; Espín et al. 2000; Arnao et al. 2001). The choice of their particular representatives to be screened was primarily made on the basis of available ethnomedicinal records (which point out the use of the fruiting bodies) and global distribution. Indeed, the aim was to check out if this type of lignicolous fungi extracts has potential to be considered as a good source of natural antioxidants to be eventually used in medicine, pharmacy and/or food industry.

2. Results and discussion

TP content ranged from 138 to 157 mg GAE/g d.e. for *S. commune* and *F. fomentarius* hydrodistilled extracts, respectively (Table 1); the latter value is ≈ 2 × higher than the obtained one for the ethanol extract (82.54 mg GAE/g d.e.) of the same fungal species (*F. fomentarius*; originating from different habitat, Novi Sad–Serbia) performed in a common way excluding the hydrodistillation step (Karaman 2009). Nowacka et al. (2015) have recently reported relatively similar TP content (53.13 mg GAE/g d.e.) for the Polish *F. fomentarius* (collected in Lublin Province) ethanol extract performed in a standard way. Finally, the water extract of the same fungus originating from Iran contained 9.90 μg GAE/100 μg extract (Vazirian et al. 2014). On the other hand, Indian researchers have found 12.50 μg GAE/mg of dry extract

| Parameter                        | *Fomes fomentarius* | *Schizophyllum commune* |
|----------------------------------|---------------------|-------------------------|
| Total phenolic content [mg GAE/g d.e.] | 157 ± 8             | 138 ± 7                 |
| Asc [%]                          | 50.60               | 70.40                   |
| DPPH [μg/mL]                     | 1.31 ± 0.06         | 12.14 ± 0.60            |
| ABTS [mg TE/g d.e.]              | 110 ± 5             | 195 ± 9                 |
| •NO [μg/mL]                      | 599 ± 24            | 2514 ± 101              |

Table 1. Experimental data of *Fomes fomentarius* and *Schizophyllum commune* samples.
(d.e.) in the common *S. commune* ethanol extract (Devi et al. 2014). Furthermore, TP contents of the methanol and water extracts of *S. commune* (purchased from local markets in Malaysia) were reported to be 1.72 and 0.52 mg GAE/g of dry extracts, respectively (Mirfat et al. 2010). The use of hydrodistillation which destroys sporoderm of the fungal hymenia resulting in translocation of great amount of phenolics stored in the spores may partially explain such a result. The quantitative differences observed are also likely to be related to the places of harvesting and climatic conditions. While the examined *F. fomentarius* extract was the most active towards DPPH radical (1.31 μg/mL), the *S. commune* hydrodistilled extract was found to exhibit the highest antiradical potential against Asc radical (70.40%) (Table 1). In comparison, Karaman et al. (2014) have pointed out an 8-fold less anti-DPPH radical activity (≈ 10.70 μg/mL) for the *F. fomentarius* ethanol extract obtained by standard procedure.

### 3. Experimental

See supplementary material for more information.

### 4. Conclusion

Taken all together, both *F. fomentarius* and *S. commune* hydrodistilled extracts may be considered as enhanced resources of natural phenolics and other bioactive substances with antiradical potential to be used in medicine, pharmaceutical and/or food industries.

### Disclosure statement

No potential conflict of interest was reported by the authors.

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### References

Arnao MB, Cano A, Acosta M. 2001. The hydrophilic and lipophilic contribution to total antioxidant activity. Food Chem. 73:239–244.
Barros L, Dueñas M, Ferreira ICFR, Baptista P, Santos-Buelga C. 2009. Phenolic acids determination by HPLC–DAD–ESI/MS in sixteen different Portuguese wild mushrooms species. Food Chem. Toxicol. 47:1076–1079.
Chen W, Zhao Z, Chen SF. 2008. Optimization for the production of exopolysaccharide from *Fomes fomentarius* in submerged culture and its antitumor effect *in vitro*. Bioresour Technol. 99:3187–3194.
Devi LS, Dasgupta A, Chakraborty M, Borthakur SK, Singh NI. 2014. Chemical composition and antioxidant activity of *Schizophyllum commune*. Int J Pharm Sci Res. 27:173–178.
Espín JC, Soler-Rivas C, Wichers HJ. 2000. Characterization of the total free radical scavenger capacity of vegetable oils and oil fractions using 2,2-diphenyl-1-picrylhydrazyl radical. J Agric Food Chem. 48:648–656.
Green CE, Wagner DA, Glogowski J, Skipper PL, Wishnok JS, Tannenbaum SR. 1982. Analysis of nitrate, nitrite and nitrate in biological fluids. Anal Biochem J. 243:709–714.
Grienke U, Zöll M, Peintner U, Rollinger JM. 2014. European medicinal polypores—a modern view on traditional uses. J Ethnopharmacol. 154:564–583.
Han CH, Liu QH, Ng TB, Wang HX. 2005. A novel homodimeric lactose–binding lectin from the edible split gill medicinal mushroom Schizophyllum commune. Biochem Biophys Res Commun. 336:252–257.

He J, Feng X, Lu Y, Zhao B. 2003. Fomlactones A–C, novel triterpene lactones from Fomes cajanderi. J Nat Prod. 66:1249–1251.

Heleno SA, Martins A, Queiroz MJRP, Ferreira ICFR. 2015. Bioactivity of phenolic acids: metabolites versus parent compounds: review. Food Chem. 173:501–513.

Karaman M. 2009. Autochthonous species of Basidomycota – potential resources of bioactive substances [dissertation]. Novi Sad, Serbia: University of Novi Sad.

Karaman M, Stahl M, Vulić J, Vesić M, Čanadanović-Brunet J. 2014. Wild-growing lignicolous mushroom species as sources of novel agents with antioxidative and antibacterial potentials. Int J Food Sci Nutr. 65:311–319.

Matavulj MN, Lolic SB, Vujic SB, Milovac S, Novakovíc MS, Karaman MA. 2013. Schizophyllum commune: the main cause of dying trees of the Banja Luka arbored walks and parks. Proc Nat Sci Matica Srpska Novi Sad. 124:367–377.

Mirfat AHS, Noorliday A, Vikineswary S. 2010. Scavenging activity of Schizophyllum commune extracts and its correlation to total phenolic content. J Trop Agric. 38:231–238.

Nowacka N, Nowak R, Drozd M, Olech M, Los R, Malm A. 2015. Antibacterial, antiradical potential and phenolic compounds of thirty-one polish mushrooms. PLoS ONE. 10:e0140355.

Park YM, Kim IT, Park HJ, Choi JW, Park KY, Lee JD, Nam BH, Kim DG, Lee JY, Lee KT. 2004. Anti-inflammatory and anti-nociceptive effects of the methanol extract of Fomes fomentarius. Biol Pharm Bull. 27:1588–1593.

Ruán-Soto F, Garibay-Orijel R, Cifuentes J. 2006. Process and dynamics of traditional selling wild edible mushrooms in tropical Mexico. J Ethnobiol Ethnomed. 2:3.

Schmidt O. 2006. Wood and tree fungi: biology, damage, protection, and use. Hamburg: Springer.

Seniuk OF, Gorovoj LF, Beketova GV, Savichuk HO, Rytk PG, Kucherov II, Prilutsky AB, Prilutsky Al. 2011. Anti-infective properties of the melanin-glucan complex obtained from medicinal tinder bracket mushroom, Fomes fomentarius (L.: Fr.) Fr. (Aphyllophoromycetidae). Int J Med Mushroom. 13:7–18.

Sigler L, Bartley JR, Parr DH, Morris AJ. 1999. Maxillary sinusitis caused by medusoid form of Schizophyllum commune. J Clin Microbiol. 37:3395–3398.

Singleton VL, Orthofer R, Lamuela-Raventós RM. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. Meth Enzymol. 299:152–178.

Smith J, Rowan S, Sullivan R. 2002. Medicinal mushrooms: their therapeutic properties and current medical usage with special emphasis on cancer treatments. London: University of Strathclyde/Cancer Research.

Tripathi AM, Bhupendra NT. 2013. Biochemical constituents of a wild strain of Schizophyllum commune isolated from Achanakmar-Amarkantak Biosphere Reserve (ABR). World J Microb Biot. 29:1431–1442.

Vazirian M, Dianat S, Manayi A, Ziari R, Mousazadeh A, Habibi E, Saednia S, Amanzadeh Y. 2014. Anti-inflammatory effect, total polysaccharide, total phenolics content and antioxidant activity of the aqueous extract of three basidiomycetes. Res J Pharmacogn. 1:15–21.

Větrovský T, Volfíšková J, Šnajdr J, Gabriel J, Baldrian P. 2011. Ecology of coarse wood decomposition by the saprotrophic fungus Fomes fomentarius. Biodegradation. 22:709–718.

Yim HS, Chye FY, Ho SK, Ho CW. 2009. Phenolic profiles of selected edible wild mushrooms as affected by extraction solvent, time and temperature. As J Food Ag-Ind. 2:392–401.