Antioxidant and antimicrobial capacities of *Ganoderma lucidum*

**Abstract**

The present study aimed to determine the total antioxidant status (TAS), total oxidant status (TOS), oxidative stress index (OSI) and antimicrobial activities of *Ganoderma lucidum* mushroom collected in Oguzeli region (Gaziantep province, Turkey). Rel Assay Diagnostics kits were used to determine TAS, TOS and OSI levels. Antimicrobial activity was determined using 9 different bacteria and fungi (*Staphylococcus aureus, S. aureus MRSA, Enterococcus faecalis, Escherichia coli, Pseudomonas aeruginosa, Acinetobacter baumannii, Candida albicans, Candida krusei and Candida glabrata*) using modified agar dilution method. The study findings demonstrated that *G. lucidum* had high antioxidant potential. Antimicrobial activity of the mushroom was also found to be normal. Thus, the consumption of *G. lucidum* as a natural source of antioxidants and an antimicrobial resource could be suggested.

**Keywords:** *Ganoderma lucidum*, medicinal mushroom, antioxidant, oxidant, antimicrobial

**Introduction**

Mushrooms, one of the functional nutrients consumed for centuries, were always among the natural material rich in fiber, proteins, vitamins and minerals. In addition to their property as functional nutrients, several mushroom species possess natural pharmacological potential. Only a few studies were conducted on important pharmaceutical mushrooms even today, despite the fact that these studies reported ant proliferative, antimicrobial, and antioxidant, antitumor, antiallergic, hypoglycemic, anti-inflammatory and immune-enhancing properties of the investigated mushroom species. Thus, it is not surprising that the interest in investigating the medicinal properties of wild mushrooms has increased over time.

*Ganoderma lucidum*, a cosmopolitan mushroom species, is a polypore rack mushroom that changes its color during growth until maturity from orange-white to bright red. There are both historical and contemporary research that supported the use of *G. lucidum* in various conditions including chronic inflammation and cancer. Its potent anti-oxidant and liver protective properties help slow the aging process, thus it is known as the “mushroom of immortality”. The anti-cancer properties act as a powerful supplement in several malignancies, especially breast cancer and lymphoma, and recent studies demonstrated surprising safety profile in these cases.

The present study aimed to determine the total antioxidant status, total oxidant status and oxidative stress index of *Ganoderma lucidum* (Curtis) P. Karst mushroom collected in Gaziantep province Oguzeli region (Turkey) in order to identify the antioxidant capacity of the mushroom.

**Material and Method**

*G. lucidum* mushrooms were collected in Gaziantep province (Oguzeli region) in Turkey (Figure 1). The samples were transported to the laboratory environment under adequate conditions and extracted with methanol (MeOH) and dichloromethane (DCM) in Soxhlet extractor (Gerhardt). The extracts were concentrated in a rotary evaporator (Heidolph Laborator 4000 Rotary Evaporator).

TAS, TOS and OSI tests

Rel Assay brand commercial kits were used to determine *G. lucidum* mushroom TAS, TOS and OSI levels. Trolox was used as the calibrator in the TAS tests and hydrogen peroxide was used as the calibrator in TOS tests. When calculating the OSI value, TAS and TOS units were equalized and the proportion of the two values was calculated. Thus, the OSI percentage value was calculated.

**TAS, TOS and OSI tests**

Antimicrobial Activity Tests

Antimicrobial activity assays on mushroom MeOH and DCM extracts were conducted with the agar dilution method as recommended by the Clinical and Laboratory Standards Institute (CLSI) and the European Committee on Antimicrobial Susceptibility Testing (EUCAST). Minimal inhibitory concentrations (MIC) for
each extract were tested against standard bacterial and fungal strains. *Staphylococcus aureus* ATCC 29213, *Staphylococcus aureus* MRSA ATCC 43300, *Enterococcus faecalis* ATCC 29212, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Klebsiella pneumoniae* ATCC 700603, *Acinetobacter baumannii* ATCC 19606, *Candida albicans* ATCC 10231, *Candida krusei* ATCC 34135 ATCC 13803, and *Candida glabrata* ATCC 90030 were used as test microorganisms. Bacterial strains were pre-cultured in Muller Hinton Broth medium and fungal strains were pre-cultured in RPMI 1640 Broth medium. The turbidity of bacteria and fungi was prepared according to McFarland 0.5 scale to obtain a standard inoculum. All extracts were tested at 800–12.5 µg/mL concentrations and all dilutions were conducted with distilled water. The solvents used in the extracts were tested lean for antimicrobial activity. Fluconazole and amphotericin were used as reference drugs for fungi and Amikacin, Ampicillin and Ciprofloxacin were used as reference drugs for bacteria. The lowest dilution that inhibited the propagation of bacteria and fungi was determined as the minimal inhibitory concentration (MIC). 

**Results and discussion**

**TAS, TOS, and OSI**

In the present study, *G. lucidum* mushroom TAS, TOS and OSI values were determined for the first time in literature. The findings are presented in Table 1.

<table>
<thead>
<tr>
<th>G. lucidum</th>
<th>TAS (µmol/L)</th>
<th>TOS (µmol/L)</th>
<th>OSI (µmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.509±0.198</td>
<td>10.177±0.116</td>
<td>0.185±0.008</td>
<td></td>
</tr>
</tbody>
</table>

No data are available in the literature for the TAS, TOS and OSI values were determined for the first time in literature. The findings are presented in Table 1.

**Table 2** Antimicrobial Activity of *G. lucidum*

<table>
<thead>
<tr>
<th></th>
<th><em>S. aureus</em></th>
<th><em>S. aureus</em> MRSA</th>
<th><em>E. faecalis</em></th>
<th><em>E. coli</em></th>
<th><em>P. aeruginosa</em></th>
<th><em>A. baumannii</em></th>
<th><em>C. albicans</em></th>
<th><em>C. glabrata</em></th>
<th><em>C. krusei</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>DCM</td>
<td>200</td>
<td>200</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>100</td>
<td>100</td>
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<tr>
<td>MeOH</td>
<td>200</td>
<td>200</td>
<td>100</td>
<td>100</td>
<td>200</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>50</td>
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<tr>
<td>Ampicillin</td>
<td>1.56</td>
<td>3.12</td>
<td>1.56</td>
<td>3.12</td>
<td>3.12</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Amikacin</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.56</td>
<td>-</td>
<td>3.12</td>
<td>3.12</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>1.56</td>
<td>3.12</td>
<td>1.56</td>
<td>1.56</td>
<td>3.12</td>
<td>3.12</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>Fluconazole</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.12</td>
<td>3.12</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Amphotericin B</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.12</td>
<td>3.12</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The MIC values are presented in units of µg/mL.

It was determined that mushroom MeOH extracts were effective on test microorganisms at concentrations of 100-200µg/mL. Furthermore, it was found that mushroom DCM extracts were effective on test microorganisms at concentrations of 100-200µg/mL. Previous studies demonstrated that different concentrations of *G. lucidum* aqueous extracts were effective on *Bacillus anthracis*, *B. cereus*, *B. subtilis*, *Micrococcus luteus*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella oxytoca*, *K. pneumoniae*, *Proteus vulgaris*, *Salmonella typhimurium* and *Serratia marcescens.* It was reported that different concentrations of *G. lucidum* MeOH extracts were effective on *S. aureus*, *B. cereus* *Listeria monocytogenes*, *Micrococcus flavus*, *P. aeruginosa*, *E. coli*, *S. typhimurium* and *Enterobacter cloaceae*. In the present study, MeOH and DCM extracts of *G. lucidum* were used. It was determined that the extracts exhibited antimicrobial effects in different concentrations on *S. aureus*, *S. aureus* MRSA, *E. faecalis*, *E. coli*, *P. aeruginosa*, *A. baumannii*, *C. albicans*, *C. glabrata* and *C. krusei* test microorganisms. Thus, it was concluded that *G. lucidum* was a natural antimicrobial agent against tested microorganisms.

**Conclusion**

In the present study, antioxidant and antimicrobial activities of wild *G. lucidum* mushroom were determined. In conclusion, it was determined that the mushroom exhibited high antioxidant activity. It could also be consumed as a natural antimicrobial agent against tested microorganisms.

**Acknowledgments**

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Conflicts of Interest

No conflict of interest was declared by the authors.

References


