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Antioxidant Potential and Element Contents of Wild Edible Mushroom *Suillus granulatus*

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ABSTRACT

Mushrooms are important natural resources in natural ecosystems. They have been used for centuries as a means of food, medicine and religious rituals for humans. In this study, total antioxidant status (TAS), total oxidant status (TOS), oxidative stress index (OSI) and Cr, Cu, Mn, Fe, Ni, Cd, Pb and Zn contents of edible mushroom *Suillus granulatus* (L.) Roussel were determined. Mushroom samples were collected from Hatay-Antakya (Turkey). Ethanol extracts of mushroom samples were obtained. TAS, TOS and OSI values were measured using Rel Assay kits. Cr, Cu, Mn, Fe, Ni, Cd, Pb and Zn contents were determined by atomic absorption spectrophotometer. As a result of the study, TAS value of *S. granulatus* was 3.143 ± 0.068 mmol/L, TOS value was 18.933 ± 0.195 µmol/L and OSI value was 0.603 ± 0.007. Cr content of *S. granulatus* was found to be high. As a result, wild edible mushroom *S. granulatus* had antioxidant potential.

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Yabani Yenilebilir Mantar *Suillus granulatus*'un Antioksidan Potansiyeli ve Element İçerikleri

ÖZET

Mantarlar doğal ekosistemlerde önemli doğal kaynaklardandır. Yüzyıllardır insanlar için besin, ilaç ve dini ritüellerde araç olarak kullanılmıştır. Bu çalışmada yenilebilir bir tür olan *Suillus granulatus* (L.) Roussel mantarının toplam antioksidan seviyesi (TAS), toplam oksidan seviyesi (TOS), oksidatif stres indeksi (OSI) ve Cr, Cu, Mn, Fe, Ni, Cd, Pb ve Zn içerikleri belirlenmiştir. Mantar örnekleri Hatay-Antakya (Turkey) ilinden toplanmıştır. Toplanan mantar örneklerinin etanol özütleri elde edilmiştir. TAS, TOS ve OSI değerleri Rel Assay kitleri kullanılarak ölçülmüştür. Cr, Cu, Mn, Fe, Ni, Cd, Pb ve Zn içerikleri atomik absorpsiyon spektrofotometresi kullanılarak belirlenmiştir. Yapılan çalışmalar sonucunda *S. granulatus*'un TAS değeri 3.143±0.068, TOS değeri 18.933±0.195 ve OSI değeri 0.603±0.007 olarak belirlenmiştir. *S. granulatus*'un Cr içeriğinin ise yüksek seviyelerde olduğu görülmüştür. Sonuç olarak *S. granulatus* mantarının antioksidan potansiyelinin olduğu belirlenmiştir.

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INTRODUCTION

Living organisms produce free radicals as a result of their metabolic activity. The levels of these free radicals can be increased by environmental and inherent effects. In cases where free radicals increase, the antioxidant defense system is activated and reduces or suppresses the effects of free radicals (Selamoglu et al., 2016; Bal et al., 2017). Oxidative stress occurs when the antioxidant defense system is insufficient against free radicals. As a result of oxidative stress, serious health problems such as cancer, cardiovascular and neurodegenerative diseases and premature aging may occur. In such cases, dietary supplementation antioxidants can be used to suppress or reduce oxidative damage (Gulhan et al., 2014; Selamoglu et al., 2016). There are many different natural sources with dietary supplement antioxidant properties. These fortified antioxidants are very rich in diversity (Sevindik et al., 2017). Since ancient times, people have consumed mushrooms for different

purposes (Ergönül et al., 2017; İnci and Kırbag, 2018). Mushrooms are very important foods because of their easy digestion and high nutritional content. In addition to nutritional properties, many mushrooms species have been reported to have medicinal potential. Previous studies have reported that mushrooms have many biological activities such as anti-angiogenic, antioxidant, anti-inflammatory, anticancer, antitumor, anti-HIV, anti-genotoxic and antimicrobial activities (de Oliveira et al., 2002; Song et al., 2003; Kim et al., 2004; Nith et al., 2007; El Dine et al., 2008; Bozdogan et al., 2016; Bozok et al., 2016; Gürgen et al., 2018; Taşkın et al., 2018; Bal et al., 2019; Inci et al., 2019).

In this study, the potential of wild edible mushroom *Suillus granulatus* (L.) Roussel as a natural antioxidant agent was evaluated. In addition, element levels of mushroom were determined. In this context, TAS, TOS and OSI values of mushrooms and Cr, Cu, Mn, Fe, Ni, Cd, Pb, Zn contents were determined.

MATERIAL and METHOD

Extraction Study

Samples of *S. granulatus* were collected from Hatay-Antakya (Turkey) in 2018. Mushroom samples were dried in the incubator at 40 ℃ and pulverized by mechanical grinding. Overall, 20 g of powdered mushroom samples were weighed and extracted with 200 mL ethanol (EtOH) in a soxhlet apparatus at 50 ℃ for about 6 hours. After extraction, the solvent was removed in a rotary evaporator under pressure and the extract was obtained. The extracts were stored at +4 ^{0}C until the experiment was performed.

Antioxidant and Oxidant Studies

TAS and TOS values of *S. granulatus* EtOH extract were determined using Rel Assay kits (Assay Kit Rel Diagnostics, Turkey). Trolox was used for kit calibration in TAS tests. TAS results are expressed as mmoL Trolox equiv./L (Erel 2004). Hydrogen peroxide was used for kit calibration in TOS tests. TOS results are expressed as µmoL H_2O_2 equiv./L (Erel 2005). OSI value (Arbitrary unit: AU) is determined according to the following formula (Erel, 2005). Analyzes were carried out with 5 replicates.

$$OSI\ (AU): \frac{TOS\ (\mu mol\ H2O2\ equiv./L)}{TAS\ (mmol\ Trolox\ equiv./L\ )X\ 10}$$

Determination of Heavy Metal Content

Mushroom samples were dried at 80 ºC for constant weighing in order to determine Cr, Cu, Mn, Fe, Ni, Cd, Pb and Zn contents. 0.5 g of these samples were taken and mineralized in a mixture of 9 mL HNO3 + 1 mL H_2O_2 in a microwave solubilizer (Milestone Ethos Easy). The elemental contents of the mushrooms were then determined using the atomic absorption spectrophotometer (Agilent 240FS AA) (Sevindik et al., 2017).

RESULTS and DISCUSSION

Antioxidant and Oxidant Activity

Antioxidant and oxidant potentials of wild edible mushroom *S. granulatus* were investigated in this study. The TAS value of *S. granulatus* was determined 3.143±0.068 mmol/L, TOS value was 18.933±0.195 µmol/L and OSI value was 0.603±0.007. There are no studies in the literature regarding the determination of TAS, TOS and OSI values of *S. granulatus*. In studies on different wild edible mushrooms, the TAS values of *Lentinus tigrinus, Cerioporus varius, Clavariadelphus truncatus, Gyrodon lividus* and *Laetiporus sulphureus* were reported as 1.748, 2.312, 2.415, 2.077 and 2.195 mmol/L, respectively. In addition, TOS values were reported as 19.294, 14.358, 3.367, 13.465 and 1.303 µmol/L, respectively. OSI values were reported as 1.106, 0.627, 0.140, 0.651 and 0.059 (Bal 2018; Sevindik 2018a; Sevindik et al., 2018a; Sevindik 2018b; Sevindik 2019). In our study, TAS value of *S. granulatus* was found higher than *L. tigrinus, C. varius, C. truncatus, G. lividus and L. sulphureus*. TAS value reflects the whole of enzymatic and nonenzymatic antioxidant molecules produced by mushrooms. In this context, it is seen that *S. granulatus* has high capacity to produce antioxidant compounds. In addition, the differences in TAS values of mushrooms are thought to have changed due to substrate, region and mushroom species. In addition, antioxidant activity of n-hexane, ethyl acetate, aqueous and methanol extracts of *S. granulatus* has been reported in previous studies (Ribeiro et al., 2006; Tel et al., 2013; Chen et al., 2018).

TOS value shows the oxidant compounds produced by mushroom as a result of environmental and metabolic activities. In our study, the TOS value of *S. granulatus* was found lower than *L. tigrinus* and higher than *C. varius, C. truncatus, G. lividus* and *L. sulphureus*. In this context, it is observed that *S. granulatus* produces more oxidant compounds than other mushrooms. The main reason for the high TOS values of *S. granulatus* is their potential to produce and accumulate oxidant compounds, differences in metabolic processes, differences in mushrooms habitat characteristics and mushroom species. For this reason, it is recommended that fungi or any natural products with high TOS values from these regions carried out in a more controlled manner.

When the OSI values are examined, it is seen that *S. granulatus* suppresses the oxidant compounds produced by its endogenous antioxidant compounds better than *L. tigrinus, C. varius* and *G. lividus* mushroom. However, the antioxidant defense system of *S. granulatus* was more passive than that of *C.*

truncatus and *L. sulphureus*. As a result, it was determined that *S. granulatus* has antioxidant potential. In addition, it is recommended that the mushroom's antioxidant potential should not be over-consumed.

Heavy Metal Contents

Mushrooms play an important role in the breakdown of organic matter in the ecosystem. In this context, they accumulate elements at different levels depending on the content of the substrate (Kalač and Svoboda, 2000). The determination of elemental levels of edible mushroom is therefore very important. Because heavy metals accumulate at high levels in mushrooms can adversely affect human health. In this study, Cr, Cu, Mn, Fe, Ni, Cd, Pb and Zn levels of wild edible mushroom *S. granulatus* were determined. The results are shown in Table 1.

Table 1. Heavy Metal Contents
Çizelge 1. Ağır Metal İçerikleri

Element contents (mg.kg^{-1}) (*Element içerikleri)*		Literature ranges (mg.kg^{-1}) (*Literatür aralıkları)*
Cr	48.82±2.27	3.34-42.70
Cu	9.37±0.96	1.90-109.95
Mn	94.01±3.55	5.25-103
Fe	193.38±4.19	14.6-835
Ni	3.82±0.12	0.18-12.88
Cd	1.35±0.11	0.16-7.50
Pb	10.37±0.85	0.68-16.54
Zn	28.27±2.03	7.13-158

In the previous studies on wild mushrooms, the lowest and highest ranges for the elements reported 3.34-42.70 for Cr, 1.90-109.95 for Cu, 5.25-103 for Mn, 14.6-835 for Fe, 0.18-12.88 for Ni, 0.16 -7.50 for Cd, 0.68-16.54 for Pb and 7.13-158 mg.kg^{-1} for Zn (Kalač and Svoboda, 2000; Svoboda and Chrastny, 2008; Zhu et al., 2010; Gebrelibanos et al., 2016; Sevindik et al., 2018b). Only Cr content of *S. granulatus* used in our study was found to be higher than the literature ranges. Cu, Mn, Fe, Ni, Cd, Pb and Zn levels of mushrooms were found in the literature. In this context, it is determined that *S. granulatus* accumulate Cr more than other elements.

CONCLUSIONS

In this study, total antioxidant status, total oxidant status, oxidative stress index and heavy metal contents of wild edible mushroom *S. granulatus* were determined. As a result of the studies, it was determined that the mushroom has antioxidant potential. In addition, it can be used as an indicator of the element Cr.

Statement of Conflict of Interest

Authors have declared no conflict of interest.

Author's Contributions

The contribution of the authors is equal.

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