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Antioxidant and Oxidant Potantials and Element Contents of *Chroogomphus rutilus* (Agaricomycetes)

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Abstract: In this study, antioxidant and oxidant status of ethanol extract of *Chroogomphus rutilus* (Schaeff.) O.K. Mill. were determined. In addition, the element contents of the cap and stipe parts were measured. Antioxidant (TAS) and oxidant states (TOS) were determined using Rel Assay Diagnostics kits. Element contents (Cr, Cu, Mn, Fe, Ni, Cd, Pb and Zn) were determined using atomic absorption spectrophotometer. As a result of the study, the TAS value of *C. rutilus* was determined 2.769±0.100, the TOS value was 9.437±0.238 and the OSI value was 0.341±0.007. In addition, it was determined that Cu, Mn, Fe, Cd and Zn elements were accumulated more in the cap part of the mushroom, and Cr, Ni and Pb elements were more accumulated in the stipe part. As a result, it was determined that *C. rutilus* has antioxidant potential. It can be used as a natural material in pharmacological designs.

Key words: Antioxidant, *Chroogomphus rutilus*, Element, Medicinal mushroom, Oxidant

Chroogomphus rutilus'un (Agaricomycetes) Antioksidan ve Oksidan Potansiyelleri ve Element İçerikleri

Öz: Bu çalışmada *Chroogomphus rutilus* (Schaeff.) O.K. Mill. antioksidan ve oksidan durumları belirlenmiştir. Ayrıca şapka ve sap kısımlarının element içerikleri ölçülmüştür. Antioksidan (TAS) ve oksidan durumları (TOS) Rel Assay Diagnostics kitleri kullanılarak belirlenmiştir. Element içerikleri (Cr, Cu, Mn, Fe, Ni, Cd, Pb ve Zn) atomik absorbsiyon spektrofotometresi kullanılarak belirlenmiştir. Çalışma sonucunda *C. rutilus*'un TAS değeri 2.769±0.100, TOS değeri 9.437±0.238 ve OSİ değeri 0.341±0.007 olarak belirlenmiştir. Ayrıca mantarın şapka kısmında Cu, Mn, Fe, Cd ve Zn elementlerinin daha fazla, sap kısmında ise Cr, Ni ve Pb elementlerinin daha fazla biriktiği belirlenmiştir. Sonuç olarak *C. rutilus*'un antioksidan potansiyelinin olduğu ve farmakolojik dizaynlarda doğal materyal olarak kullanılabileceği belirlenmiştir.

Anahtar kelimeler: Antioksidan, *Chroogomphus rutilus*, Element, Tıbbi mantar, Oksidan

Introduction

Mushrooms are organisms that appear in different ecosystems, especially after rainfall. They have been used by people for different purposes since ancient times. Mushrooms are often used as a food source. However, looking at the ancient sources, it is found that it was used in the treatment of diseases and in religious ceremonies. (Özparlak et al., 2016; İnci et al., 2019). There are species with different characteristics among mushrooms. Some of these species stand out with their nutritious properties, while others stand out with their medicinal properties. Nutritious mushrooms are rich in protein, including most essential amino acids (Baba et al., 2012; Gedik et al., 2019). They are also rich in most water-soluble vitamins and pro-vitamin D (Kurtzman, 1997). Medicinal mushrooms contain biologically active compounds. (İnci and Kırbağ, 2018). In many studies, wild mushrooms have been reported to have anti-aromatase, anti-angiogenic, hypoglycemic, immunomodulatory, anti-inflammatory, insecticidal, antiallergic, anticancer, antioxidant, antimicrobial, antiproliferative and DNA protective effects (Wang et al., 2002; Song et al., 2004; Han et al., 2006; Chen et al., 2008; Jedinak et al., 2011; Alkan et al., 2017; Bal et al., 2017; Wang et al., 2018; Canlı et al., 2019).

C. rutilus, an edible species, is a cosmopolitan species that is brown color. It has ectomycorrhizal association especially with *Pinus* members (Ji et al., 2011). In our study, antioxidant and oxidant potentials and levels of some elements of *C. rutilus* were determined.

Material and metod

C. rutilus samples were collected from Bahçe/Osmaniye (Turkey) region. 30 g of collected mushroom samples were extracted with ethanol (EtOH) for approximately 6 hours at 50 °C using the soxhlet device (Gerhardt EV 14). The extracts obtained were concentrated with a rotary evaporator (Heidolph Laborota 4000 Rotary Evaporator).

Total Antioxidant and Oxidant status: Total antioxidant and oxidant states of EtOH extract of *C. rutilus* were determined using Rel Assay TAS and TOS kits. Trolox (TAS) and hydrogen peroxide (TOS) were used as calibrators (Erel, 2004, 2005). The oxidative stress index (OSI (Arbitrary Unit = AU)) of the mushroom was applied as follows (Erel, 2005).

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

Element Analyses: In order to determine the elemental analysis (Cr, Cu, Mn, Fe, Ni, Cd, Pb and Zn) of *C. rutilus*, the samples were dried at 80 °C up to constant weighing. 0.5 g of the mushroom samples were mineralized using a microwave solubilizer (Milestone Ethos Easy) in a mixture of 9 mL HNO_3 + 1 mL H_2O_2. After the mineralization process, the element contents were determined using an atomic absorption spectrophotometer device (Agilent 240FS AA) (Sevindik et al., 2017).

Results and Discussion

Total Antioxidant and Oxidant Status: Living organisms of the ecosystem produce oxidant compounds as a result of metabolic activities in their bodies (Monaghan et al., 2009). While these oxidant compounds act as catalysts in some metabolic activities in low amounts, high levels can cause serious damage to the living organism. Endogenous antioxidants come into play to prevent this harmful process from occurring (Willcox et al., 2004). However, in cases where endogenous antioxidants are insufficient, supplemental antioxidants are required. In this context, it is important to identify natural products with antioxidant potential to be taken through diet (Sevindik, 2020). TAS, TOS and OSI values of EtOH extract of *C. rutilus* were determined in our study. The findings obtained are shown in Table 1.

Table 1. TAS, TOS and OSI values of *C. rutilus*

Sample	TAS (mmol/L)	TOS (µmol/L)	OSI
Chroogomphus rutilus	2.769±0.100	9.437±0.238	0.341±0.007

* Values are presented as mean±SD; Experiments were made in 5 parallels

It has been emphasized in previous studies that *C. rutilus* has antioxidant potential using different methods (DPPH Free Radical Scavenging Assay, β-Carotene/Linoleic Acid Assay, ABTS Cation Radical Decolorisation Assay, Cupric Reducing Antioxidant Capacity (CUPRAC), Ferrous Ions Chelating Activity) (Ji et al., 2011; Çayan et al., 2014; Zhang et al., 2017; Zhang et al., 2020). In this study, the antioxidant potential of *C. rutilus* was determined for the first time using TAS kits. There are studies on different wild mushrooms using TAS kits. TAS value of *Laetiporus sulphureus* (Bull.) Murrill was reported as 2.195 mmol/L, TOS value was 1.303 µmol/L and OSI value was 0.059 (Sevindik et al., 2018). TAS value of *Suillus granulatus* (L.) Roussel was reported as 3.143 mmol/L, TOS value was 18.933 µmol/L and OSI value was 0.603 (Mushtaq et al., 2020). TAS value of *Tricholoma virgatum* (Fr.) P. Kumm. was reported as 3.754 mmol/L, TOS value was 8.362 µmol/L and OSI value was 0.223 (Selamoglu et al., 2020). TAS value of *Clavariadelphus truncatus* Donk was reported as 2.415 mmol/L, TOS value was 3.362 µmol/L and OSI value was 0.140 (Sevindik, 2018). TAS value of *Lycoperdon molle* Pers. was reported as 7.52 mmol/L (Emsen et al., 2019). TAS value shows the whole of the antioxidant compounds in the mushroom (Bal, 2018). Compared to these studies, it was determined that the TAS value of *C. rutilus* was higher than *L. sulphureus* and *C. truncatus* and lower than *L. molle, S. granulatus* and *T. virgatum*. The reason for the difference in TAS value among mushroom species is thought to be due to the mushroom's potential to produce antioxidant compounds. It has also been determined that *C. rutilus* has an antioxidant potential.

In addition, the TOS value shows the whole of the oxidant compounds produced by the fungus (Bal, 2018). The variability in TOS values is due to the species' potential to produce oxidant compounds and their hatitat. The OSI value shows how much oxidant compounds produced in the mushroom are suppressed by endogenous antioxidants. As the OSI value increases, it is seen that the antioxidant defense system in the mushroom is insufficient (Bal, 2018). It is seen that the TOS and OSI values of *C. rutilus* were higher than *L. sulphureus, C.*

truncatus, T. virgatum and *C. truncatus*, but lower than *S. granulatus*. These results show that *C. rutilus* is weak in suppressing the oxidant compounds it produces. As a result, it is recommended not to consume excessively in case of consumption of mushrooms.

Element Contents: Mushrooms play an important role in ensuring the ecological cycle. In this context, they serve in the breakdown of organic cover. As a result of this process, they accumulate elements at different levels in their bodies (Dursun et al., 2006; Sarıkürkçü et al., 2020). In our study, the Cr, Cu, Mn, Fe, Ni, Cd, Pb and Zn levels accumulated in the cap and stipe parts of *C. rutilus* were measured. The findings obtained are shown in Table 2.

Table 2. Element Contents of cap and stipe of *C. rutilus* (mg.kg^{-1})

Parts	Cr	Cu	Mn	Fe	Ni	Cd	Pb	Zn
Cap	1.40±0.27	57.13±1.73	26.13±1.89	108.78±3.76	0.77±0.13	3.76±0.63	4.18±0.44	168.34±4.04
Stipe	2.54±0.11	49.11±0.80	15.82±0.53	36.99±2.31	1.14±0.09	1.08±0.16	8.96±0.61	129.18±2.52

*Values are presented as mean±S.D.; n=3 (Experiments were made as 3 parallel)

As a result of the elemental analysis of *C. rutilus*, it is seen that Cr, Ni and Pb elements accumulate more in the stipe part, while Cu, Mn, Fe, Cd and Zn contents are accumulated more in the cap part. The lowest and highest element levels in element analysis on wild mushrooms were reported as 9.63-42.7 for Cr, 60.33-95 for Cu, 18.1-103 for Mn, 14.6-835 for Fe, 0.67-5.14 for Ni, 2.71-7.5 for Cd, 2.86-16.54 for Pb and 29.8-158 for Zn mg.kg^{-1}. (Svoboda and Chrastny, 2008; Zhu et al., 2010; Gebrelibanos et al., 2016). In our study, it is seen that the Cr, Cu and Ni contents of *C. rutilus* are lower than the literature ranges of the cap and stipe parts. It has been determined that the cap and stipe parts of Mn, Fe and Pb contents are within the literature ranges. Less accumulation of Cd content in the stipe parts compared to literature ranges was observed. It was determined that the Cd accumulated in the cap part is within the range of the literature. It was observed that the Zn content of the mushroom was higher than the literature ranges in the cap part, and it was within the literature ranges in the stipe part. In this context, it is seen that *C. rutilus* accumulates more elements in the cap part.

Conclusion

In this study, the antioxidant and oxidant potential of *C. rutilus* was determined. In addition, the element contents of the cap and stipe parts were determined. As a result of the studies, it was seen that the mushroom has an antioxidant potential. It was also determined that it accumulated more elements in the cap part. As a result, it is thought that mushrooms can be a natural source of antioxidants in pharmacological designs.

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