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ANTIOXIDANT POTENTIAL AND SOME MINERAL CONTENTS OF WILD EDIBLE MUSHROOM *Ramaria stricta*

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Abstract

People have used mushrooms for many different diseases for thousands of years. Although mushrooms are considered as nutrients for the first time, it has been determined by researches that they have medicinal properties. In this study, antioxidant status, oxidant status and some mineral contents of wild edible mushroom Ramaria stricta (Pers.) Quél were determined. The antioxidant and oxidant states of the mushroom were measured using Rel Assay kits. Element contents were determined using atomic absorption spectrometry. In this study, the antioxidant potential of R. stricta mushroom used in our study has been evaluated to be high in term of total antioxidant status (TAS) values (4.223 ± 0.054 mmol/l), total oxidant status (TOS) values (8.201 ± 0.095 µmol/l), and oxidative stress index (OSI) value (0.194 ± 0.001). Fruitbodies of R. stricta contains essential mineral elements which are of immense health benefit. The highest Fe content (451.21 ± 5.56 $mg.kg^{-1}$) was found in mushroom samples. It was established high Cu content (95.54 ± 2.06 $mg.kg^{-1}$), and Zn content (39.19 ± 1.07 $mg.kg^{-1}$). Ni content was 7.17 ± 0.32 $mg.kg^{-1}$. A lower content (2.18 ± 0.10 $mg.kg^{-1}$) was recorded for Pb. In addition, element contents were found to be at normal levels. As a result, R. stricta mushroom is thought to be a natural antioxidant source.

Key words*: antioxidant, oxidant, edible mushroom, Ramaria stricta.*

INTRODUCTION

Mushrooms are one of the most important elements of natural ecosystems. They are the indispensable elements of the ecological cycle. They are involved in the disintegration of organic matter in environments where they spread (Canli et al., 2016; İnci and Kırbag, 2018). Besides their ecological importance, mushrooms are important natural foods. It is one of the delicious foods of the human diet. They are rich in minerals (Gürgen et al., 2018). They also contain many essential amino acids, proteins, being rich in vitamin B. Edible mushrooms proved significant medicinal properties due to their high polysaccharide content, especially β-glucans (İnci et al., 2019).
Many studies have shown that mushrooms have different medicinal properties (Gedik et al., 2019). In previous studies, mushrooms have been reported to have many different activities such as antioxidant, antimicrobial, anti-cancer, anti-angiogenic, anti-inflammatory, anti-proliferative, antitumor, anti-HIV, anti-genotoxic, anti-aging, anti-gout, anti-cholinesterase, anti-hyperlipemia, anti-gastric ulcer activity, anti-allergy, DNA protective activity, anti-hypoxic, anti-diabetic, Immunomodulatory activity and anti-thrombotic activity (de Oliveira et al., 2002; Jose et al., 2002; Song et al., 2003; Kim et al., 2004; Lavi et al., 2006; Bae et al., 2007; El Dine et al., 2008; Weng et al., 2010; Kang et al., 2011; Kim et al., 2013; Li et al., 2015; Pandimeena et al., 2015; Devi and Maiti, 2016; Nguyen et al., 2016; Bal et al., 2017; Sevindik et al., 2018a).
Ramaria is a genus with about 200 species. There are species that spread in different ecosystems of the world of *Ramaria* genus. In addition to *R. formosa* and *R. pallida*, which cause nausea, vomiting and diarrhea, there are also types such as edible *R. flava*. The antioxidant activities of some *Ramaria* species are shown in Table 1. *Ramaria stricta* (Pers.) Quél., commonly known as the strict-branch coral of the genus *Ramaria* (Petersen and Scates, 1988; Braeuer et al., 2018). It has a

cosmopolitan distribution, and grows on dead wood, stumps, trunks, and branches of both deciduous and coniferous trees (Kuo, 2009).

Table 1. Antioxidant activities of *Ramaria* species

Mushroom species	Country	Extraction	References
Ramaria flava	China, Turkey	Ethanol, Hexane, Methanol, Aqueous	Gursoy et al., 2010; Liu et al., 2013; Öztürk et al., 2014; Bozdogan et al., 2016; Sadi et al., 2016
R. largentii	Romania	Ethanol	Aprotosoaie et al., 2017
R. botrytis	China	Water, Methanol, petroleum ether	Kim and Li, 2003; Froufe et al., 2009; Li 2017
R. aurea	India	Ethanol, methanol, Aqueous	Khatua et al., 2015; Zengin et al., 2017
R. formosa	India	Methanol	Ramesh and Pattar, 2010
R. botrytoides	China	Methanol	Guo et al., 2012
R. subalpina	India	Methanol	Acharya et al., 2017
R. fennica	Turkey	Methanol	Bakır et al., 2018

The aim of this study is the determination of antioxidant status, oxidant status and Fe, Zn, Cu, Pb and Ni contents of wild edible mushroom *Ramaria stricta* (Pers.) Quél.

MATERIALS AND METHODS

R. stricta samples were collected in 2019 from Bilyayivka, Odessa region (Ukraine). The mushroom samples were dried in an incubator at 40°C. 30 g of dried mushroom samples were weighed and powdered. Then, mushroom was extracted with ethanol (EtOH) in the Soxleth apparatus during approximately 6 hours at 50°C. A rotary evaporator was used to remove the solvent from the obtained extract. The extracts were kept at +4°C until experiment.

Total Antioxidant and Oxidant Studies

Total antioxidant status (TAS) values were determined using Rel Assay TAS kits (Erel, 2004). Total oxidant status (TOS) values were determined using Rel Assay TOS kits (Erel, 2005). Trolox was used as TAS calibrator and hydrogen peroxide was used as TOS calibrator. Oxidative stress index (OSI) value (Arbitrary unit: AU) was determined according to the formula below (Erel, 2005):

$$\text{OSI (AU)} = \frac{\text{TOS, } \mu\text{mol } H_2O_2 \text{ equiv./l}}{\text{TAS, mmol Trolox equiv./l X 10}}$$

Determination of Element Content

Samples were dried at 80ºC until constant weight to determine the Fe, Zn, Cu, Pb, and Ni contents of *R. stricta*. It was mineralized in a mixture of 9 ml HNO_3+1 ml H_2O_2 in the microwave solubilizer (Milestone Ethos Easy) by taking 0.5 g of 5 samples. The element contents of the samples were determined using an atomic absorption spectrophotometer device (Agilent 240FS AA) (Sevindik et al., 2017).

Statistical analysis

The experimental results were expressed as means ± SEM (standard error of the mean) of triplicates. The data was analysed with Excel statistical functions using the Microsoft Office 2016. Differences at $P \leq 0.05$ were considered to be significant.

RESULTS AND DISCUSSIONS

Total Antioxidant and Oxidant Status

Mushrooms have the potential to produce many antioxidant enzymes and coenzymes in secondary metabolite structure. Mushrooms, which are rich in nutrient content, contain vitamins with strong antioxidant characteristics such as A, C and E. In this context, it is very important natural products (Rathore et al., 2017). TAS values are an indicator of the endogenous antioxidants they produce (Selamoglu et al., 2016). Mushrooms with high TAS values have the potential to be an important antioxidant natural source. TOS values are an indicator of produced oxidant compounds (Selamoglu et al., 2017). High TOS values show that mushrooms produce more reactive oxygen types under the influence of environmental factors and people should pay attention to the consumption of these products. Thus, these indicators allow us to evaluate the antioxidant potential in the complex. However, there are very few studies to determine TAS, TOS and OSI values of mushrooms. In our study, TAS, TOS and OSI values of EtOH extract of *R. stricta* were determined. The findings obtained are shown in Table 2.

In literature, TAS, TOS and OSI values of *R. stricta* have not been determined. But, there are analogical studies of the antioxidant potential of different wild mushrooms.

Table 2. TAS, TOS and OSI values of *R. stricta*

Sample	TAS (mmol/l)	TOS (µmol/l)	OSI
R. stricta	4.223±0.054	8.201±0.095	0.194±0.001

*Values are presented as mean ± S.D
*Experiments were made as 5 parallel

Compared to these studies, TAS value of *R. stricta* was found higher than *Cerioporus varius* (2.312 mmol/l) (Sevindik, 2019), *Laetiporus sulphureus* (2.195 mmol/L) (Sevindik et al., 2018b), *Lepista nuda* (3.102 mmol/l) (Bal et al., 2019), *Lentinus tigrinus* (1.748 mmol/l) (Sevindik, 2018), and lower than *Leucoagaricus leucothites* (8.291 mmol/l) (Sevindik et al., 2018c).It is thought that this difference between the TAS values of mushrooms is due to the differences in their potential to produce antioxidant compounds. In addition, these differences may occur depending on the differences, levels, and diversity of secondary metabolites produced by the mushrooms as a reaction of the defense system depending on internal and external factors. The high TAS value of *R. stricta* in our study shows that mushrooms can be used as an important natural antioxidant source. In the literature, it was also reported that petroleum ether extracts of *R. stricta* show significant antioxidant activity (Sharma and Gautam, 2017).

Compared to TOS values of other mushroom species, it was established that TOS value of *R. stricta* was higher than those of *L. sulphureus* (1.303 µmol/l) (Sevindik et al., 2018b) and lower than *L. tigrinus* (19.294 µmol/l) (Sevindik, 2018), *C. varius* (14.358 µmol/l) (Sevindik, 2019), *L. nuda* (36.920 µmol/l) (Bal et al., 2019), and *L. leucothites* (10.797 µmol/l) (Sevindik et al., 2018c).

The differences in the TOS studies conducted with different mushroom species obtained from different localities attract attention.

It is thought that the main reason for this difference in TOS values is due to differences in the environmental factors and metabolic processes of the mushrooms. Consumption of a natural product with a high TOS value may pose problems for human health (Korkmaz et al., 2018).

And according to our results, the OSI values of *R. stricta* samples had higher values than *L. leucothites* (0.130) (Sevindik et al., 2018c) and *L. sulphureus* (0.059) (Sevindik et al., 2018b), and lower than *L. tigrinus* (1.106) (Sevindik, 2018), *C. varius* (0.627) (Sevindik, 2019), and *L. nuda* (1.190) (Bal et al., 2019). These differences in OSI values arise from the fact that the antioxidant system of mushroom is effective at different levels against oxidant compounds. As a result, OSI values of *R. stricta* were low.

This is because the fungi antioxidant system is potent and effective against oxidant compounds.

Element Contents

Mushrooms, which acts as a decomposing role in the ecosystem, accumulate different levels of elements within the body depending on the substrate content. Because of these properties, they are important element indicators (Baba et al., 2012). In this study, Fe, Cu, Zn, Pb and Ni contents of *R. stricta* were determined. The results are shown in Table 3.

Element contents may vary depending on the habitats collected from mushrooms consumed in different parts of the world. The maximum and minimum ranges of Fe, Zn, Cu, Pb and Ni levels detected in different wild mushrooms were shown in Table 4.

It was observed that the contents of Fe, Zn, Cu and Pb of *R. stricta* used in our study were in line with literature data. Ni content of *R. stricta* was found to be higher than the ranges specified in the literature.

Table 3. Element contents of *R. stricta*

Sample	**Fe** ($mg.kg^{-1}$)	**Zn** ($mg.kg^{-1}$)	**Cu** ($mg.kg^{-1}$)	**Pb** ($mg.kg^{-1}$)	**Ni** ($mg.kg^{-1}$)
R. stricta	451.21±5.56	39.19±1.07	95.54±2.06	2.18±0.10	7.17±0.32

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

Table 4. Range of reported literature values (mg/kg dry weight) of different mushrooms

Elements	Values (mg/kg dry weight)	References
Iron (Fe)	14.60-1714	Sarikurkcu et al., 2011; Sevindik et al., 2018a
Zinc (Zn)	7.63-240	Falandysz et al., 2007
Copper (Cu)	1.90-180	Falandysz et al., 2008; Sevindik et al., 2018c
Lead (Pb)	0.18-16.54	Nikkarinena and Mertanen, 2004; Sevindik et al., 2018a
Nickel (Ni)	0.67-6.72	Vetter, 1990; Sevindik et al., 2018a

CONCLUSIONS

In this study, total antioxidant level, total oxidant level, oxidative stress index and element contents of wild edible mushroom *R. stricta* were determined. Wild edible mushroom *R. stricta* is thought to be an important antioxidant source. It is recommended that daily consumption is limited in terms of element toxicity.

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