Research Article

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Medical Mycology: Open Access
ISSN 2471-8521

2017
Vol.3 No.2:25

DOI: 10.21767/2471-8521.100025

Geastrum pectinatum as an Alternative Antioxidant Source with some Biochemical Analysis

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Received date: September 26, 2017, **Accepted date:** October16, 2017,**Published date:** October 20, 2017

Abstract

The present study aimed to determine and compare total antioxidant status (TAS), total oxidant status (TOS), oxidative stress index (OSI) and Fe, Zn, Pb, Cu and Ni content of *Geastrum pectinatum* Pers. mushroom that was collected in different areas in Antalya province (Geyikbayiri and Termessos National Park). TAS, TOS and OSI values were measured using Rel Assay kits. Heavy metal content was determined with atomic absorption spectrophotometry using the wet decomposition method. Study findings demonstrated that samples collected in Termessos National Park had more suitable heavy metal and oxidative stress conditions when compared to those collected in Geyikbayiri. Furthermore, it was considered that due to the high TAS values, the said mushroom could be consumed as a natural antioxidant source in alternative medicine.

Keywords: *Geastrum pectinatum*; Antioxidant; Oxidant; Oxidative stress; Heavy metal; Antalya; Turkey

Introduction

Since the early days of civilization, mushrooms have been used as nutrients and medicines [1]. In addition to nutrient properties, mushrooms are also noted for their medicinal properties. Plants contain many phytochemicals with medicinal properties in their bodies. It has been proven that fungi, like plants, may contain some phytochemicals in a similar way and thus exhibit significant bioaccumulation [2,3]. Today, along with the increase in molecular studies, their use in biological warfare as well as in the production of antibiotic and other pharmacological products has increased [4,5]. Synthetic drugs used by humans are preferred due to their capacity to provide a healthy life and increase the defense system despite their toxic and mutagenic effects [6]. However, the use of natural pharmacological agents may reduce these adverse effects in living beings. Previous studies demonstrated that mushrooms have antimicrobial, antibacterial, anti-carcinogenic, antioxidant, antiviral, anti-inflammatory, anticoagulant, cytotoxic, cytostatic, antiatherogenic, antioxidant, anti-allergic, hypoglycemic and immunosuppressive properties [7-19]. Thus, determination of biological activities of mushrooms is significant to reveal new pharmacological agents.

In addition to their medicinal properties, mushrooms also function in the organic matter break up, which is very significant for the sustenance of life in the nature [20,21]. Mushrooms could be used as pollution indicators based on the levels of the elements they accumulate in the environment depending on the substrate content they consume in the environment they are cultured [22,23]. Thus, the determination of heavy metal levels that fungi collect in their physical structures would enable determination of the level of pollution in the environment, as well as preventing health problems that would arise in case of their consumption.

In this context, determination and comparison of total antioxidant status (TAS), total oxidant status (TOS), oxidative stress index (OSI) and heavy metal content (Fe, Zn, Cu, Pb and Ni) of *Geastrum pectinatum* Pers. mushroom were aimed in the present study.

Material and Method

G. pectinatum samples were collected in Geyikbayiri (Konyaalti) and Termessos National Park in Antalya province (Turkey) in 2015. The collected mushroom samples were dried in an incubator in the laboratory at 40°C. Dried samples were pulverized by mechanical grinder. Then, 30 g pulverized sample was weighed and extracted with ethanol in the Soxhlet device (BUCHI Extraction System Model B-811).

Determination of TAS, TOS and OSI values

Mushroom sample TAS and TOS values were determined using the Rel Assay brand commercial kit (Rel Assay Kit Diagnostics, Turkey). For TAS, Trolox, and for TOS, hydrogen peroxide were used as calibrators. TAS values were presented in mmol Trolox equiv./L and TOS values were presented in µmol H_2O_2 equiv./L [24,25]. OSI value, which indicates the level that the oxidant

compounds in the mushroom was inhibited by antioxidant compounds, was calculated with the formula below [25]:

$$OSI = \frac{TOS,\ \mu\ mol H_2O_2 equiv./L}{TAS, mmol\ Trolox\ equiv./L\ X\ 10}$$

Determination of heavy metal content

The heavy metal content in the mushroom samples were determined with wet decomposition method. For this purpose, mushroom samples were initially dried at 40°C and then pulverized. One gram pulverized sample was weighed in 3 replicates and placed in 50 ml glass beakers. 10 ml HNO_3 was added. The samples were then stored at ambient temperature for 1-2 days. Then the beakers were heated with a hot plate until the solution became clear. Then, 10 ml concentrated HCl was added and the heating process was repeated. Then, 20 ml diluted HCl was added to the solution and the solution was prepared for analysis by filtration [26]. The element concentrations of the prepared solutions were determined with a Perkin Elmer (AAnalyst 400) instrument.

Results and Discussion

TAS, TOS and OSI Values

G. pectinatum ethanol extract TAS (mmol/L), TOS (µmol/L) and OSI values were determined with Rel Assay kits. The values are presented in **Table 1**.

Table 1: TAS, TOS and OSI Values of *G. pectinatum*.

	TAS	TOS	OSI
Termessos National Park	1.091 ± 0.075	7.553 ± 0.274	0.692 ± 0.023
Geyikbayiri	1.278 ± 0.032	13.858 ± 0.154	1.084 ± 0.015

The TAS values for the *G. pectinatum* samples collected in Geyikbayiri and Termessos National Park were 1.278 and 1.091 mmol/L, respectively. The TOS values for the same samples were determined as 13.858 and 7.553 µmol/L, respectively. OSI values were 1.084 and 0.692, respectively. In previous oxidative stress studies conducted on various mushrooms, it was determined that *Tricholoma terreum* (Schaeff.) P. Kumm TAS value was 0.38, and *Coprinus micaceus* (Bull.) Fr. TAS value was 0.46, Pleurotus eryngii (DC.) Quél. TAS value was 1.93, *Auricularia auricula* (L.) Underw. TAS value was 1.010, and *Trametes versicolor* (L.) Lloyd TAS value was 0.820 [3,27,28]. In comparison with the above mentioned values, it was found that TAS values of the samples collected in two different areas in the present study were lower than *P. eryngii* mushroom. It was also determined that the samples collected in two different areas had higher TAS values when compared to *T. terreum*, *A. polytricha*, *A. auricula* and *T. versicolor* mushrooms. It was found in previous studies that *T. terreum* TOS value was 16.76, *C. micaceus* TOS value was 16.87, *A. auricula* TOS value was 23.910 and *T. versicolor* TOS value was 17.760. OSI value of *T. terreum* was determined as 4.41, OSI value of *C. micaceus* was determined as 3.67, OSI value of *A. auricula* was determined as 2.367 and OSI value of *T. versicolor* was determined as 2.166 [3,26]. In comparison with these studies, it was determined that the TOS and OSI values of the samples collected in two different areas in the present study were lower. In the current study, it could be argued that Geyikbayırı and Termessos National Park were more suitable environments for the growth of mushrooms based on oxidative stress status when compared to the areas where *T. terreum*, *C. micaceus*, *A. auricula* and *T. versicolor* mushrooms grew. It could also be argued that *G. pectinatum* could be consumed as a natural antioxidant source due to its high total antioxidant levels.

Heavy metal content

Soil and *G. pectinatum* mushroom Fe, Zn, Cu, Pb and Ni content were determined in the conducted analyses and presented as average ± Std in **Table 2**.

Table 2: Heavy metal levels of *G. pectinatum*.

	Fe	Zn	Cu	Pb	Ni
G. pectinatum (Termessos- Mushroom)	291.45 ± 5.73	18.60 ± 5.37	9.57 ± 2.44	8.09 ± 0.77	0.07 ± 0.01
G. pectinatum (Termessos-Soil)	601.75 ± 7.77	27.13 ± 2.33	28.49 ± 0.61	35.63 ± 2.61	42.68 ± 1.58
G. pectinatum (Geyikbayiri - Mushroom)	434.10 ± 12.09	60.51 ± 4.69	22.25 ± 0.99	6.20 ± 6.39	12.88 ± 4.30
G. pectinatum (Geyikbayiri- Soil)	811.34 ± 2.88	42.78 ± 0.41	69.13 ± 0.57	38.87 ± 1.71	34.54 ± 1.36

The elements that exist in the habitat of mushrooms and that accumulate in their structures in different amounts based on the substrate they utilize could be used as pollution indicators [22]. As a result of the conducted heavy metal analyses; the Fe, Zn, Pb, Cu and Ni content in *G. pectinatum* mushroom collected in Geyikbayır were 434.10 ± 12.09, 60.51 ± 4.69, 6.20 ± 6.39, 22.25 ± 0.99 and 12.88 ± 4.30, respectively and *G. pectinatum* mushroom collected in Termessos National Park were 291.45 ± 5.73, 18.60 ± 5.37, 8.09 ± 0.77, 9.57 ± 2.44 and 0.07 ± 0.01, respectively. The Fe, Zn, Pb, Cu and Ni content in the soil samples obtained from the habitat of *G. pectinatum* were 811.34 ± 2.88, 42.78 ± 0.41, 38.87 ± 1.71, 69.13 ± 0.57 and 34.54 ± 1.36 for the samples collected in Geyikbayiri, respectively. For the samples collected in Termessos National park the same figures were measured as 601.75 ± 7.77, 27.13 ± 2.33, 35.63 ± 2.61, 28.49 ± 0.61 and 42.68 ± 1.58. Study data demonstrated

This article is available from: 10.21767/2471-8521.100025

that the heavy metal levels were higher in *G. pectinatum* collected in Geyikbayiri and the soil samples collected in this region. Thus, the content of the substrate found in the mushroom habitat seems to be reflected the heavy metal levels found in the mushroom structure. The minimum and maximum heavy metal content in mushrooms were determined as follows in the literature: 14.6-835 for Fe, 29.8-306 for Zn, 64.8-290 for Cu, 0.04-6.88 for Pb and 1.18-5.14 mg.kg-1 for Ni [29-31]. Compared to these values, it was determined that Fe content of samples collected from both areas in the present study were within the range that was determined in the literature. It was observed that the Zn content was lower in the samples collected in Termessos National Park when compared to the range reported in the literature. Cu content in both regions were lower than the range reported in the literature. It was determined that Pb content was higher than the range reported in the literature in samples collected in Termessos National Park. It was determined that the Ni content was lower than the range reported in the literature in the samples collected in Termessos National Park and higher in soil samples collected in Geyikbayiri area. It was considered thet the abovementioned differences in heavy metal content were due to the differences in substrate content in the environment where the mushrooms were collected.

Conclusion

Based on the conducted study, it could be argued that the heavy metal content in the regions where *G. pectinatum* was collected were suitable. It was also determined that oxidative stress values differed between the regions. The high TAS values in *G. pectinatum* demonstrated that samples collected in more suitable sites based on oxidative stress values could be consumed as an alternative antioxidant source.

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This article is available from: 10.21767/2471-8521.100025