Edible mushrooms as promising antioxidants

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Abstract: Antioxidant activity of the acetone extracts of the mushrooms *Macrolepiota procera* and *Chlorophyllum rhacodes* has been screened *in vitro* by using different methods (DPPH radical scavenging and reducing power assay), and also it has been determined the total phenolic compounds as total flavonoid content. The research findings indicate that the acetone extract of *M. procera* demonstrated superior antioxidant activities when compared to *C. rhacodes*. Similarly, the mushroom *M. procera* displayed a more pronounced effect on reducing power. In addition, the total content of phenol and flavonoid in extracts were determined as pyrocatechol equivalent, and as rutin equivalent, respectively. A higher content of total phenols and flavonoids was detected in the extract of *M. procera*. The strong relationships between total phenolic and flavonoid contents and the antioxidative activities of tested extracts imply that these compounds have a significant impact on antioxidant activity. The present study highlights that the tested mushroom species exhibit potent antioxidant properties and can be regarded as valuable sources of natural antioxidants.

Keywords: mushrooms, acetone extract, antioxidant activity

1. Introduction

Edible mushrooms are extensively consumed in numerous countries. Their consumption has experienced a substantial rise due to their delectable flavor, convenient availability, and appeal as functional foods. Aside from their nutritional benefits, mushrooms have the potential to be utilized for therapeutic intentions as they can generate a wide array of secondary metabolites, including organic acids, alkaloids, terpenoids, steroids, and phenolic compounds [1]. In the past few years, there has been an increasing focus on edible mushrooms as a viable resource of antioxidants in the commercial sphere.
This study evaluated the antioxidant activity of two closely related edible mushroom species *Macrolepiota procera* (Scop.) Singer 1948 (commonly referred to as the

parasol mushroom) and *Chlorophyllum rhacodes* (Vittad.) Vellinga 2002 (known as the shaggy parasol) that are widely consumed in Serbia because of their availability and appealing flavor.

Despite the extensive research conducted on edible mushrooms across various countries, only a limited number of studies have investigated the antioxidant properties of these specific two species of edible mushrooms [1, 2, 3]. Therefore, the aim of the present work is to evaluate the antioxidant activity of the acetone extract of *M. procera* and *C. rhacodes* found in Serbia.

2. Materials and Methods

Mushroom samples of *M. procera* and *C. rhacodes* were collected from Kragujevac, Serbia, in October of 2020. Finely dry ground dried thalli of the examined mushrooms (100 g) were extracted using acetone (500 mL) in a Soxhlet extractor, Quickfit, England. The dry extracts were dissolved in 5% dimethyl sulfoxide (DMSO).

The antioxidant activity of mushroom extracts was assessed using the 1,1-diphenyl-2-picryl-hydrazil (DPPH) method. Although the method was slightly modified, it was similar to approaches employed by other researchers [4, 5]. The absorbance was measured at 517 nm using a spectrophotometer. The DPPH radical concentration was calculated using the following equation (1):

$$DPPH\ scavenging\ ability\,(\%) = \frac{[A_0 - A_1]x100}{A_0} \quad (1)$$

where A_0 is the absorbance of the negative control and A_1 is the absorbance of the reaction mixture or standards.

The determination of the reducing power of the extracts followed the methodology established by Oyaizu [6]. The absorbance of the resulting solution was measured at 700 nm using a spectrophotometer. A blank sample was prepared with all the reaction agents without extract. Ascorbic acid was used as a positive control.

The phenolic compounds in the mushroom extracts were determined with Folin-Ciocalteu reagent, following the method described by Slinkard and Singleton [7]. Pyrocatechol was used as a standard phenolic compound. The absorbance of the solution was measured at 760 nm using a spectrophotometer. The total concentration of phenolic compounds in the extracts was determined in micrograms of pyrocatechol equivalent (PE) per milligram of dry extracts.

The determination of total flavonoid content followed the Dowd method, as described by Meda *et al*. [8]. Absorbance of the solutions was measured at 415 nm using a spectrophotometer, comparing against blank samples. The total flavonoid content was quantified as micrograms of rutin equivalent (RE) per miligram of dry extracts.

3. Results and Discussion

The DPPH radical scavenging and reducing power of the examined extracts are presented in Table 1. Acetone extracts of the tested mushrooms exhibited moderate scavenging activity against DPPH radicals. The results in these tables indicate that the extract derived from *M. procera* exhibited higher antioxidant activities compared to *C. rhacodes*. The antioxidant activities of the tested samples were also compared to ascorbic acid, which demonstrated stronger activity as a standard antioxidant. The results of the reducing power assay demonstrate that the reducing capability of the extracts varies with concentration.

Table 1. DPPH radical scavenging (%) activity of acetone extracts of *M. procera* and *C. rhacodes*

Mushroom species	DPPH radical scavenging (%)					Reducing power		
	2 mg/mL	1 mg/mL	0.5 mg/mL	0.25 mg/mL	0.125 mg/mL	1000 μg/mL	500 μg/mL	250 μg/mL
M. procera	48.47	31.60	16.36	8.89	3.27	0.144	0.093	0.047
C. rhacodes	10.33	10.94	6.34	4.09	0.31	0.097	0.056	0.041
Ascorbic acid	-	-	-	-	-	2.113	1.654	0.096

The total phenolic and flavonoid contents of the mushroom extracts are given in Table 2. Acetone extract of *M. procera* has greater values of phenolic content (13.12 μg PE/mg extract), while higher amounts of flavonoid compounds were found in the extract of *C. rhacodes* (33.42 μg RE/mg extract).

Table 2. Total phenolic and flavonoid content of acetone extracts of acetone extracts of *M. procera* and *C. rhacodes*

Mushroom species	Phenolic content (μg PE/mg extract)	Flavonoid content (μg RE/mg extract)
M. procera	13.12	5.76
C. rhacodes	8.53	33.42

In the literature there are several data for the antioxidant activity of *M. procera* and *C. rhacodes* [1, 2, 3]. They determined antioxidant activity for these species but for other extraction solvents used. Kosanić *et al*. [1] reported that the antioxidant activity of the methanol extract of *M. procera* showed the most potent reducing power and total phenolic content. Akata *et al*. [2] reported the proximate composition of *C. rhacodes* and the highest content of proteins of all other tested species.

Varying outcomes have been observed in studies investigating the antioxidant effects of mushrooms belonging to the same genera. Various factors such as strain differences, developmental stage, age of mushrooms, storage conditions, and the extraction method, particularly the choice of solvent, can influence the concentrations of substances which are responsible for the antioxidant properties [9].

4. Conclusion

The utilization of mushrooms offers several advantages compared to the use of various chemical compounds, primarily due to their varied bioactive properties. This study has provided evidence that the acetone extracts of *M. procera* and *C. rhacodes* exhibit moderate antioxidant effects. Due to the widespread availability and abundance of these edible species, it is strongly recommended to include them in one's diet, and in the pharmaceutical industry. Further investigation is necessary to identify the specific active compounds responsible for the bioactive observed in the selected mushroom species.

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