RESEARCH ARTICLE

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Functional Food *Agaricus arvensis*: Antioxidant and Antimicrobial Potentials

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ABSTRACT: Mushrooms used in complementary medicine come to the fore with many different biological activities. In this study, antioxidant and antimicrobial potentials of *Agaricus arvensis* Schaeff. mushroom were determined. In our study, the ethanol extract of the mushroom was obtained in a soxhlet device. The antioxidant and oxidant potential of the mushroom was determined using Rel Assay kits. Antimicrobial activity was tested against standard strains using the agar dilution method. As a result of the analyses, the TAS value of *A. arvensis* was determined as 2.253±0.216, the TOS value was 15.252±0.314, and the OSI value was 0.679±0.052. The mushroom extract was effective against bacterial strains at 100-400 µg/mL concentration, and against fungus strains at 200 µg/mL concentration. As a result, it was determined that *A. arvensis* has antioxidant and antimicrobial potential.

Keywords: Antimicrobial, antioxidant, medicinal mushroom, *Agaricus arvensis*

INTRODUCTION

Mushrooms are produce bioactive compounds responsible for many biological activities (Bal et al., 2017; Sevindik et al., 2017a). These compounds vary according to the type of mushroom. Some mushrooms are edible, some medicinal, and some poisonous (Akgül et al., 2017; Sevindik et al., 2018a; Davis et al., 2020). Many studies have shown that mushrooms have biological activities such as antioxidant, antimicrobial, anticancer, DNA protective, anti-inflammatory, antiparasitic, antiallergic, hepatoprotective (Ellertsen and Hetland, 2009; Akgül et al., 2016; Liu et al., 2017; Sevindik et al., 2017b; Kothari et al., 2018; Muszyńska et al., 2018; Sevindik 2018a; Baosong et al., 2020; Mushtaq et al., 2020; Gürgen et al., 2020; Nkadimeng et al., 2020; Özaltun and Sevindik, 2020; Shahzad et al., 2020). In this context, it is important to investigate fungi, which are important natural agents.

Free radicals are produced in living cells as a result of environmental factors and metabolic processes (Sevindik, 2020). As a result of adverse environmental conditions, the levels of oxidant compounds in living organisms increase (Sevindik et al., 2018b). Antioxidant defense system kicks in against increasing levels of oxidant compounds (Korkmaz et al., 2018). Antioxidant defense system is insufficient against high levels of oxidant compounds. In this case, oxidative stress occurs (Sevindik et al., 2016a; Sevindik et al., 2018c). As a result of oxidative stress, serious health problems such as Parkinson's, Alzheimer's, cancer and cardiovascular diseases may occur (Sevindik, 2018b). Supplementary antioxidants have an important effect in reducing or suppressing the effect of oxidative stress (Sevindik, 2018c). In this context, it is very important to investigate mushrooms with antioxidant properties.

In recent years, there has been an increase in the number of diseases caused by microorganisms. The reason for this is thought to be due to negative interventions on the ecosystem and unconsciously used antibiotics (Sevindik, 2021). In this context, current microbial drugs are insufficient. The discovery of new drug active ingredients and resources has become inevitable. For this reason, it is very important to investigate the antimicrobial properties of mushrooms. In this context, antioxidant, oxidant and antimicrobial activities of *Agaricus arvensis* were determined in this study.

MATERIALS AND METHOD

A. arvensis specimens were collected from Gaziantep/Turkey. The drying processes of the mushroom samples were carried out under suitable conditions. 30 g were taken from the samples and extracted with ethanol in a soxhlet extractor. It was then concentrated with a rotary evaporator (Heidolph Laborota 4000 Rotary Evaporator) at 40°C.

Antimicrobial Activity Assay

The ethanol extract of mushroom was tested against *Staphylococcus aureus* ATCC 29213, *Enterococcus faecalis* ATCC 29212, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Candida albicans* ATCC 10231, *Candida*

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tropicalis ATCC 13803 using the agar dilution method. 800, 400, 200, 100, 50, 25, 12.5 and 6.25 µg/mL were used as test concentrations. The lowest concentrations that prevent the growth of bacteria and fungi were determined as the minimal inhibitory concentration (MIC) (Hindler et al., 1992; CLSI, 2002; 2003).

Antioxidant and Oxidant Tests

Antioxidant and oxidant status of mushrooms were determined using Rel Assay TAS and TOS kits (Erel, 2004; Erel, 2005). The calibrator trolox was used in antioxidant tests. The calibrator hydrogen peroxide was used in the oxidant tests. Oxidative stress index (OSI) (Arbitrary unit: AU) TOS values were proportioned to TAS values and percentage values were calculated (Sevindik, 2018d).

RESULTS AND DISCUSSION

Antimicrobial activity

Mushrooms are immutable elements of the natural ecosystem. In this context, they come face to face with many living organisms. Many studies have shown that fungi have antimicrobial activities (Onuegbu et al., 2017; Debnath et al., 2019; Pan et al., 2019; Abdalla et al., 2020; Sami et al., 2020; Kumla et al., 2021). In our study, the effects of ethanol extract of *A. arvensis* against bacterial and fungal strains were investigated. The results obtained are shown in Table 1.

Table 1. *Antimicrobial potential of Agaricus arvensis*

Sample	*S. aureus* (µg/mL)	*E. faecalis* (µg/mL)	*E. coli* (µg/mL)	*P. aeruginosa* (µg/mL)	*C. albicans* (µg/mL)	*C. tropicalis* (µg/mL)
A. arvensis	400	200	200	100	200	200

The MIC values are presented in units of µg/mL

In previous studies, methanol extract of *A. arvensis* has been reported to be effective against *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, Proteus mirabilis, Morganella morganni, Acinetobacter baumannii, Pasteurella multocida* and *Bacillus subtilis* (Alves et al. 2012; Dundar et al., 2016). In a different study, it was reported that n-hexane, chloroform and ethyl acetate extracts of *A. arvensis* were effective against *Pseudomonas syringae, Ralstonia solanacearum, Xanthomonas axonopodis* and *Erwinia carotovora* (Waqas et al., 2019). In our study, ethanol extract of *Agaricus arvensis* was used and its effect against *S. aureus, E. faecalis, E. coli, P. aeruginosa, C. albicans* and *C. tropicalis* was investigated. In our study, the highest activity was effective against *P. aeruginosa* at 100 µg/mL extract concentration. The mushroom extract was effective against *E. faecalis, E. coli, C. albicans* and *C. tropicalis* at 200 µg/mL extract concentration. The lowest activity against *S. aureus* was seen at the extract concentration of 400 µg/mL. As a result, in our study, it was determined that *A. arvensis* can be used as a natural antimicrobial agent.

Antioxidant and Oxidant status

In recent years, research has increased due to the biological potential of mushrooms (Cheung et al., 2003; Khatua et al., 2013; Smolskaitė et al., 2015; Lu et al., 2018; Umaña et al., 2020). In our study, TAS, TOS and OSI values of *A. arvensis* were determined. The obtained results are shown in Table 2.

Table 2. *TAS, TOS and OSI Values of Agaricus arvensis*

Sample	TAS	TOS	OSI
A. arvensis	2.253±0.216	15.252±0.314	0.679±0.052

Values are presented as mean±S.D

It has been reported that *A. arvensis* has antioxidant activity using DPPH scavenging activity, Reducing power activity, Metal chelating activity, Total Antioxidant activity, Super oxide anion radical activity methods (Dundar et al., 2016; Waqas et al., 2019). In this study, TAS, TOS and OSI values of *A. arvensis* were determined for the first time. In previous studies on different mushroom species, TAS values of *Ramaria stricta* (TAS: 4.223), *Helvella leucomelaena* (TAS: 2.367), *Sarcosphaera coronaria* (TAS: 1.066), *Lepista nuda* (TAS: 3.102), *Macrolepiota procera* (TAS: 2.805), *Cantharellus cibarius* (TAS: 5.268), *Tricholoma virgatum* (TAS: 3.754), *Helvella leucopus* (TAS: 2.181), *Infundibulicybe geotropa* (TAS: 1.854), *Cyclocybe cylindracea* (TAS: 4.325), *Cerioporus varius* (TAS: 2.312) have been reported (Sevindik et al., 2016b; Krupodorova and Sevindik, 2020; Sevindik et al., 2018d; Sevindik et al., 2018e; Bal et al., 2019; Sevindik, 2019a; Sevindik, 2019b; Selamoglu et al., 2020; Sevindik and Akata, 2020; Sevindik et al., 2020). Compared to these studies, TAS value of *A. arvensis* was found to be lower than *Ramaria stricta, Helvella leucomelaena, Lepista nuda, Macrolepiota procera, Cantharellus cibarius, Tricholoma virgatum, Cyclocybe cylindracea* and *Cerioporus varius*, and higher than *Sarcosphaera coronaria, Helvella leucopus* and *Infundibulicybe geotropa*. The TAS value shows the whole of the antioxidant-effective compounds produced in the mushroom (Sevindik, 2018e). In our study, it was determined that *A. arvensis* has antioxidant potential.

Also, TOS values of *Ramaria stricta* (TOS: 8.201), *Helvella leucomelaena* (TOS: 55,349), *Sarcosphaera coronaria* (TOS: 41.672), *Lepista nuda* (TOS: 36.920), *Macrolepiota procera* (TOS: 6.596), *Cantharellus cibarius* (TOS: 6.380), *Tricholoma virgatum* (TOS: 8.362), *Helvella leucopus* (TOS: 14.389), *Infundibulicybe geotropa* (TOS: 30.385), *Cyclocybe cylindracea* (TOS: 21.109) and *Cerioporus varius* (TOS: 14.358) have been reported (Sevindik et al., 2016b; Krupodorova and Sevindik, 2020; Sevindik et al., 2018d; Sevindik et al., 2018e; Bal et al., 2019; Sevindik, 2019a; Sevindik, 2019b; Selamoglu et al., 2020; Sevindik and Akata, 2020; Sevindik et al., 2020). Compared to these studies, the TOS value of *A. arvensis* was found to be lower than *Helvella leucomelaena, Sarcosphaera coronaria, Lepista nuda, Infundibulicybe geotropa* and *Cyclocybe cylindracea*, and higher than *Ramaria stricta, Macrolepiota procera, Cantharellus cibarius, Tricholoma virgatum, Helvella leucopus* and *Cerioporus varius*. The TOS value shows the environmental factors and the whole of the oxidant compounds produced in the mushrooms (Sevindik, 2018e). In our study, it was observed that the TOS value of *A. arvensis* was at normal levels.

In addition, OSI values of *Ramaria stricta* (OSI: 0.194), *Helvella leucomelaena* (OSI: 2.338), *Sarcosphaera coronaria* (OSI: 3.909), *Lepista nuda* (OSI: 1.190), *Macrolepiota procera* (OSI: 0.235), *Cantharellus cibarius* (OSI: 0.121), *Tricholoma virgatum* (OSI: 0.223), *Helvella leucopus* (OSI: 0.661), *Infundibulicybe geotropa* (OSI: 1.639), *Cyclocybe cylindracea* (OSI: 0.488) and *Cerioporus varius* (OSI: 0.627) have been reported (Sevindik et al., 2016b; Krupodorova and Sevindik, 2020; Sevindik et al., 2018d; Sevindik et al., 2018e; Bal et al., 2019; Sevindik, 2019a; Sevindik, 2019b; Selamoglu et al., 2020; Sevindik and Akata, 2020; Sevindik et al., 2020). Compared to these studies, the OSI value of *A. arvensis* was found to be lower than *Helvella leucomelaena, Sarcosphaera coronaria, Lepista nuda* and *Infundibulicybe geotropa*, and higher than *Ramaria stricta, Macrolepiota procera, Helvella leucopus, Cyclocybe cylindracea* and *Cerioporus varius*. The OSI value shows how much the oxidant compounds produced in the fungus are suppressed by the antioxidant defense system of the fungus. The increase in OSI value is an indicator of insufficient antioxidant defense system (Sevindik, 2018e). In this context, it is seen that the OSI value of *A. arvensis* is at normal levels.

CONCLUSION

In this study, antioxidant, oxidant and antimicrobial potentials of *A. arvensis* were determined. According to the results obtained, it was seen that the mushroom has antioxidant potential. In addition, it was determined that the oxidant levels were at normal levels. In addition, *A. arvensis* has been shown to have antimicrobial potential against test bacteria and fungi.

CONFLICT OF INTEREST

No conflict of interest was declared by the authors.

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