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Yellow water-lily (*Nuphar lutea* (L.) Sm.) as a Potential Functional Natural Product: Antioxidant and Antimicrobial Potentials

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ABSTRACT: Plants are widespread throughout the world in large areas. This spread also increases the interest in plants. From prehistory to the 21st century, plants have always maintained their popularity with their various uses. Among the reasons why plants have been preferred in the field of medicine recently, this popularity and the increase in the use of synthetics are the main reasons. These conditions have led to an increase in the demand for the plant. In our study, the pharmacological effect of the *Nuphar lutea* (L.) Sm. plant sample was investigated. In this context, antimicrobial and antioxidant contents were examined. Methanol (MeOH) and ethanol (EtOH) extracts of underwater and above-water leaf parts of *N. lutea* were obtained. Rel Assay kits were used for antioxidant (TAS) and oxidant (TOS) values. Agar dilution technique was used for antimicrobial analysis. In our study, the TAS value of the N. lutea sample was found as 2.987±0.071, the TOS value as 12.955±0.360 and the OSI value as 0.434±0.007. In the antimicrobial activity study, EtOH extract was effective at 100-400 µg/mL concentration against bacterial strains and at 100 µg/mL concentration against fungal strains. In addition, it was determined that the MeOH extract was effective at 200-800 µg/mL concentration against bacterial strains and 100 µg/mL against fungal strains. As a result of the studies, it was determined that the *N. lutea* plant could be used as both an antimicrobial and an antioxidant agent.

Keywords: Antimicrobial, Antioxidant, Brandy-bottle, Medicinal plants, Spadderdock, Yellow water-lily

INTRODUCTION

In addition to their nutritious properties, plants are also used as a means of religious ceremonies, pharmaceutical industry, spice and cultural preference (Pehlivan et al., 2018). Recently, plants have been used for therapeutic purposes (Lafi et al., 2022). For this purpose, the biological activities of a plant are determined by researchers (Sevindik, 2018). As a result of many studies on plants, it has been reported that they have many activities such as antioxidant, antimicrobial, anticancer and analgesic, DNA protective, antiproliferative, anti-inflammatory (Pehlivan and Sevindik, 2018; Uysal et al., 2020; Balkrishna et al., 2022; Hosny et al. ., 2022; Ralte et al., 2022; Smith and Graether, 2022). Many free radicals may occur due to cellular metabolic activities (Sevindik, 2020). Because of these free radicals reaching high levels, the cells begin to be damaged. The antioxidant defense system is activated to prevent damage to these cells (Forman and Zhang, 2021). In cases where the antioxidant defense system is insufficient, oxidative stress occurs. Supplemental antioxidants play an important role in reducing the effect of oxidative stress (Krupodorova et al., 2022). *Nuphar lutea* (L.) Sm. is a plant species in the Nymphaeaceae family. Common names are the yellow water-lily, brandy-bottle, or spadderdock. It spreads cosmopolitanly in many parts of the world. It contains five inwardly folded sepals. The leaves are numerous and the flowers are sulfur yellow. Seeds are shiny and dark brown (Wiart, 2013). In this study, antioxidant, oxidant and antimicrobial activities of *N. lutea* leaves were investigated.

MATERIALS AND METHOD

N. lutea plant specimen was obtained from the province of Hatay (Turkey). The underwater and above-water leaf parts of N. lutea were dried in a shaded environment where the air flow was sufficient and the content was not affected. 30 g of dried N. lutea plant sample was weighed with the help of precision balance. *N. lutea* plant sample, which was weighed, was pulverized with a mechanical grinder. Then, the powder sample was extracted with 200 mL methanol (MeOH) and 200 mL ethanol (EtOH) at 50 ^{0}C. Methanol and ethanol solvents in the extract were removed by Heidolph Laborota 4000 Rotary Evaporator.

Antioxidant and Oxidant Tests

Rel Assay kits were used to determine the total antioxidant (TAS) and total oxidant (TOS) status of *N. lutea*. Trolox in TAS tests and Hydrogen peroxide in TOS tests were used as calibrators (Erel, 2004; Erel, 2005). It was obtained by dividing the total oxidant results found to determine the oxidative stress index, known as OSI, by the total antioxidant results (Sevindik, 2019).

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Antimicrobial Effect

Agar dilution technique was used to determine the antimicrobial activity of EtOH and MeOH extracts of *N. lutea* plant. The effects of extracts of *N. lutea* against *Candida glabrata* ATCC 90030, *C. krusei* ATCC 34135 ve *C. albicans* ATCC 10231, *Acinetobacter baumannii* ATCC 19606, *Staphylococcus aureus* ATCC 29213, *Pseudomonas aeruginosa* ATCC 27853, *S. aureus* MRSA ATCC 43300, *Escherichia coli* ATCC 25922 and *Enterococcus faecalis* ATCC 29212 were investigated. The lowest concentration that inhibited the growth of these bacterial and fungal strains was determined (Bauer et al., 1966; Hindler et al., 1992; Matuschek et al., 2014).

RESULTS AND DISCUSSION

Antioxidant and Oxidant Effects

After the increase in disease definitions in recent years, it has been determined that the cause of many diseases is free radicals. High levels of oxidant compounds produced as a result of metabolic activities can cause oxidative stress in living organisms (Sevindik et al., 2017; Trist et al., 2019). As a result of oxidative stress, many different diseases such as cancer and cardiological disorders can occur in humans (Akgül et al., 2016; Butterfield and Halliwell, 2019). In this study, the status of *N. lutea* leaves as a natural antioxidant source to be used in suppressing oxidative stress was determined. The obtained TAS, TOS and OSI values are shown in Table 1.

Table 1. *Antioxidant and oxidant status of Nuphar lutea*

	TAS (mmol/L)	TOS (µmol/L)	OSI
Nuphar lutea	2.987±0.071	12.955±0.360	0.434±0.007

Values are presented as mean±S.D

Many studies in recent years have shown that plants have high antioxidant potential (Malik et al., 2022; Mihailova et al., 2022; Sharma et al., 2022). No study has been found in the literature to determine the total oxidant, total antioxidant and oxidative stress index values of the *N. lutea* plant. In studies on different plant species, TAS values of *Mentha longifolia* subsp. *longifolia*, *Lepidium spinosum*, *Euphorbia eriophora, Rumex scutatus, Urtica dioica, Helianthemum salicifolium, Echium italicum*, *Centaurea rigida* and *Marrubium globosum* have been reported as 3.628, 4.550, 5.390, 8.656, 7.817, 9.490, 5.442, 3.522 and 7.677, respectively. The TOS values were reported as 4.046, 12,610, 20,971, 4.951, 10,866, 14,839, 21,372, 15,424, and 12,387, respectively. OSI values were reported as 0.112, 0.277, 0.390, 0.057, 0.139, 0.157, 0.395, 0.440 and 0.162, respectively (Sevindik et al., 2017; Kına et al., 2021; Mohammed et al., 2021a; Mohammed et al., 2021b; Pehlivan et al., 2021; Uysal et al., 2021; Akgul et al., 2022; Mohammed et al., 2022; Unal et al., 2022).Compared to these studies, the TAS value of *N. lutea* was lower than *M. longifolia* subsp. *longifolia*, *L. spinosum, E. eriophora, R. scutatus, U. dioica, H. salicifolium, E. italicum, C. rigida* and *M. globosum*. The TAS value shows the whole of the antioxidant-effective compounds produced within the plant. High TAS value shows that the antioxidant potential of the plant is also high (Korkmaz et al., 2021). In this context, in our study, it was determined that the antioxidant potential of *N. lutea* is lower than other plants. The TOS value of *N. lutea* was determined to be higher than *M. longifolia* subsp. *longifolia*, *L. spinosum, R. scutatus, U. dioica* and *M. globosum*, and lower than *E. eriophora*, *H. salicifolium*, *E. italicum*, *C. rigida*. TOS values are an indicator of the whole of the oxidant compounds in the plants. High TOS values indicate that the plant can be harmful when consumed (Korkmaz et al., 2021). TOS values of *N. lutea* used in our study were found to be at normal levels. The OSI value of *N. lutea* was determined to be higher than *M. longifolia* subsp. *longifolia*, *L. spinosum*, *E. eriophora*, *R. scutatus*, *U. dioica*, *H. salicifolium, E. italicum* and *M. globosum*, and lower than *C. rigida*. The OSI value shows how much the oxidant compounds produced in the plant are suppressed by antioxidants (Korkmaz et al., 2021). It is seen that the plant used in our study is insufficient in suppressing oxidant compounds. As a result, it was determined that the antioxidant potential of the *N. lutea* sample was low.

Antimicrobial Effect

Microorganisms have become the main cause of many diseases in recent years. Antimicrobial drugs are used to combat microorganisms (Vaou et al., 2021). The emergence of resistant strains as a result of the unconscious use of antibiotics in recent years has made the discovery of new antimicrobial drugs obligatory (Sevindik, 2021). Plants are important natural materials in this context. In this study, antimicrobial activity of MeOH and EtOH extracts of *N. lutea* species was determined. The obtained results are shown in Table 2.

Table 2. *Antimicrobial Effect of Nuphar lutea*

	A	B	C	D	E	F	G	H	J
EtOH	200	200	400	200	100	100	100	100	100
MeOH	200	200	800	200	200	200	100	100	100

*(A) *S. aureus*, (B) *S. aureus* MRSA, (C) *E. faecalis*, (D) *E. coli*, (E) *P. aeruginosa*, (F) *A. baumannii*, (G) *C. glabrata*, (H) *C. albicans*, (J) *C. krusei*

*800, 400, 200 and 100 µg/mL extract concentrations

In previous studies, it has been reported that Nuphar japonicum has an antimicrobial effect against *S. aureus* using the microdilution method (Okamura et al., 2015). It has been reported that water, ethanol and methanol extracts of *N. lutea* species have antimicrobial effects against *Streptococcus pyogenes, S. aureus, S. epidermidis, E. coli, P. aeruginosa, Salmonella typhimurium, Serratia marcescens, Proteus vulgaris, Enterobacter cloacea* and *Klebsiella pneumonia* strains using the disk diffusion method (Pehlivan-Karakaş et al., 2008). It was determined that the *N. lutea* EtOH extract used in our study was generally more effective against microorganisms. The plant EtOH extract was effective at 100-400 µg/mL extract concentrations against bacterial strains and at 100 µg/mL extract concentrations against fungal strains. The plant MeOH extract was effective at 200-800 µg/mL extract concentrations against bacterial strains and at 100 µg/mL extract concentrations against fungal strains. As a result, it was determined that the plant extract was effective against test microorganisms at different concentrations. In this context, it is thought that the plant can be used as a natural antimicrobial agent.

CONCLUSION

As a result of our study, antimicrobial and antioxidant potentials of *N. lutea* plant were determined. It was determined that the EtOH extract of the plant species showed higher antimicrobial activity in general. It is seen that the antioxidant potential of the plant is lower than the plants used in the studies conducted with the same method in the literature. As a result, it is thought that *N. lutea* plant can be used as a natural antioxidant and antimicrobial agent.

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CONFLICT OF INTEREST

No conflict of interest was declared by the authors.

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