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SHORT COMMUNICATION

Phytochemical properties of essential oil from *Artemisia sieberi* Besser (Iranian accession) and its antioxidant and antifungal activities

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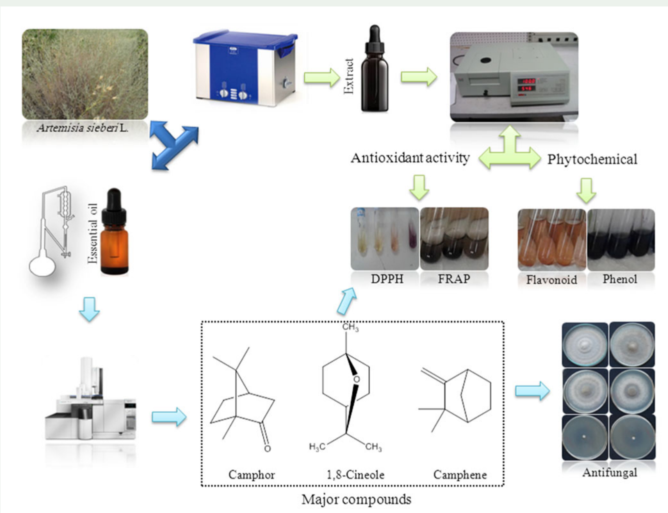
ABSTRACT

In this study, the phytochemical profile, the essential oil composition of an Iranian accession of *Artemisia sieberi* and their antioxidant and antifungal properties were investigated. The amount of essential oil yield was 1.5% (w/v) and twenty two components were identified by GC-MS analysis being camphor (33.64%), 1,8-cineole (25.66%) and chrysanthenone (7.86%) the major compounds. The amount of total polyphenols and flavonoids, total ascorbic acid and carotenoid content of *A. sieberi* extract were determined, and resulted in 666.26 mg GAE/100g DW, 54.77 mg QUE/100g DW, 153.585 mg/100g DW, and 907.18 mg/100g FW, respectively. Highest antioxidant activity based on DPPH bioassay was recorded in essential oil (84.04%) and extract (89.33%). Furthermore, the essential oil of *A. sieberi* tested for its antifungal activity, demonstrated to reduce significantly the mycelium growth rate of *Botrytis cinerea*, that is, no mycelial growth was observed at concentrations 1000 and 1500 µll^{-1}.



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1. Introduction

Artemisia sieberi Besser, belonging to the Compositae family, is a typical desert plant endemic of Iran. Previous phytochemical investigations of the extracts of the aerial part of plants growing in Iran showed the occurrence of oplopane, germcrane and eudesmane derivatives (Marco et al. 1993). Essential oils represent a sub-category of secondary metabolites which are found in aromatic plants. the ability of essential oils to reduce post-harvesting damages and the absence of damaging effects on the human health caused an increasing interest in their usage (Calo et al. 2015; Ishkeh et al. 2019). *Botrytis cinerea* is a necrotrophic fungus which kills plant cells and lives on them. This species, commonly known as gray mold of grapes, leads to a decay of fruits such as rasp berries, grapes, apples and pears. Plants, containing a high level of antioxidants, can serve as a valuable resource of active biological compounds (Mishra et al. 2012). Consequently, essential oils and non-volatile extracts are frequently used in dietary and agricultural industries in order to prevent reactive oxygen species (ROS) and fungal growth, increasing the life of foodstuffs (Scalbert et al. 2005). Consequently, this study is aimed to analyze the phytochemical profile and essential oil composition of an endemic accession of *A. sieberi* as well as the antioxidant activity of both its extract and essential oil. Besides, antifungal activity of essential oil against *B. cinerea*, one of the main sources of decay and post-harvesting damages in foodstuffs, were examined.

2. Results and Discussion

2.1. Essential oil analysis

The extracted essential oil in this experiment was a colorless and rather silver with a functionality of 1.5% (w/v) according to the dry weight. The 22 compounds identified in this study, which forms 99.99% of the overall essential oil compound, were shown in Table S1.

A major percentage of the essential oil comprised of camphor (33.64%), 1,8-cineole (25.66%), camphene (15.71%), and chrysanthenone (7.86%) which accounts for 82.87% and the remaining 17.13 percent of the essential oil was made up of other compounds.

There is a lot of information on the chemical compounds of *A. sieberi* essential oil, but most articles have reported that Cinnamic acid and Spathulenol (Guetat et al. 2017) and α, β-thujones (Mahoubi, 2017) as the main chemical compounds, while In the present study, camphor, 1,8-cineole, camphene, and chrysanthenone were the most important compounds. The results of this study showed that the majority of the compounds of the essential oil of *A. sieberi* represent 1,8-cineole, camphor, and chrysantheone all of which belong to monoterpenes. Monoterpenes are found in all plant essential oils and account for about 90 percent of the essential oils (Bakkali et al. 2008).

2.2. Antioxidant activity

Fig S1-A and B show the antioxidant activity (DPPH) of the essential oil and extract of *A. sieberi* in a variety of concentrations by time-course. Analysis of the variance of the data on the antioxidant activity of the essential oil and the extract showed that the simple concentration effect on the amount of antioxidant activity was statistically significant ($p < 0.01$). Furthermore, simple effect of time was statistically significant on the amount of antioxidant activity of the essential oil and the extract at probability level of 1 and 5 percent respectively, but effect of the interaction between concentration and time on the amount of this parameter, was not statistically significant. The result of the means comparison of the data showed that the amount of the antioxidant activity in the essential oil varied from 32.04% to 84.04% whereas in the extract it ranged from 82.82% to 89.33% ($IC_{50} = 54.37$ μl). Hence, the highest amount of the antioxidant activity in both cases was obsereved in the 75 μl concentration in 30 minutes. Normally, hydrocarbon monoterpenes contain more effective antioxidants than sesquiterpenes and other isoprenoids. Studies on the antioxidant activity, types of monoterpenes show that none of them is stronger than oxgenated monoterpenes (Zengin and Baysal, 2014). Researches have previously shown that the *A. sieberi* possess a great antioxidant potential (Lopes-Lutz et al., 2008; Boroomand et al. 2018). The amount of antioxidant activity of the extract of this plant was also higher, in comparison with the essential oil. The antioxidant activity of the extract using the FRAP method is presented in Table S2 which shows the amount of antioxidant activity with this method is 702.66 mM Fe^{++}/100g DW.

2.3. Phytochemical profile

Vitamin C or Ascorbic acid is one of the important and necessary vitamins existing in fruits and vegetables which is a subcomponent of phenolic compounds with a high antioxidant attribute. The result of the current study shows the amount of the ascorbic acid in *A. sieberi* is 153.585 mg/100g DW.

Chlorophyll is the main pigment for the absorption, conversion and alteration of energy for photosynthesis (Nishio 2000). The amount of total cartenoid and Chlorophyll a and b were measured in extract of the plant. Table S2 shows that these parameters were 907.18 mg/100g FW, 9.84 mg/100g FW and 1.27 mg/100g FW, respectively. Limited studies have been reported on the amount of carotenoid and chlorophyll compounds in *A. sieberi*.

2.4. Antifungal activity

Fig S2-A shows the amount of diametrical growth of mycelium of the *B. cinerea* fungus. The analysis of the variance showed that treatment of the essential oil of *A. sieberi* has statistically significant impact at the probability level of 0.01. Means comparison of the fungus mycelium diameter showed that the highest mycelium diameter in the treatment of control was found to be in the fifth day after cultivation whereas its lowest amount in the 1000 and 1500 $\mu l l^{-1}$ treatments of the concentration essential oil without mycelium growth was observed (Fig S2-A). Moreover, means comparison for the percentage of the mycelial growth inhibition (MGI%) showed that in the concentrations 1000 and 1500 $\mu l l^{-1}$ of the essential oil completely controlled the growth of fungus mycelium. Furthermore, no statistically significant differences were observed between the two concentrations (1000 and 1500 $\mu l l^{-1}$; Fig S2-B), which is in agreement with the results found in Siripornvisal et al. (2009). According to Fig

S2-B, the percentage of mycelial growth inhibiton of *B. cinerea* increases by increasing the concentration of essential oil and compared to the control, this increase was found to be statistically significant at the possibility level of $p < 0.001$. On the other hand, in 1000 and 1500 concentrations the percentage of inhibition was 100% (Minimum Inhibitory Concentration (MIC)= 1000 $\mu l l^{-1}$). Therefore, no statistically significant differences were found between the two concentrations. Monoterpene compounds are the main cause of the strong antifungal activity of *A. sieberi* essential oil. The results of the current study are in line with results of Vesaltalab and Gholami (2012). Due to the wide variety of antifungal compounds in essential oils, no determined independent mechanism could be mentioned as the only responsible for their diverse activities.

4. Conclusion

The results of the present study showed that *A. sieberi* essential oil has a strong inhibitory effect on the *B. cinerea* fungus growth. Because of this attributes, this essential oil and related compounds could be used in controlling and reducing the amount of damage of pathogenic factors in the harvested crops. Moreover, it can serve as a suitable alternative for chemically synthesized fungicides. *A. sieberi* essential oil can be used in disinfecting the storages and fruit packaging industries without having any harmful effects for the consumer and the environment.

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