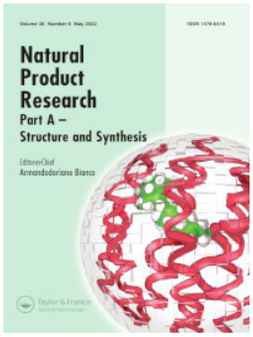

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SHORT COMMUNICATION

Essential oil composition and biological activities of *Ononis alba* Poir (Fabaceae)

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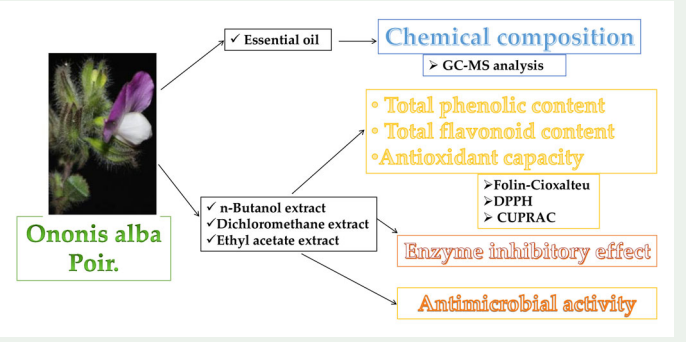
ABSTRACT

The phytochemical and biological properties of *Ononis alba* Poir L. (Fabaceae) were investigated for the first time in this study. The chemical composition of the essential oil obtained from the aerial parts was analysed by GC-MS. The phenolic contents of extracts obtained with different solvents were determined by the Folin-Ciocalteu assay and the antioxidant activity was evaluated through DPPH and CUPRAC methods. The inhibitory potential of these extracts was evaluated on α-amylase and α-glucosidase, whereas the antimicrobial effect was verified against some bacteria and fungi through the well diffusion method. Ketones and carboxylic acids were the main essential oil constituents. The highest total phenolic and flavonoid content as well as the best antioxidant capacity were noticed on the *n*-butanol extract. All the extracts showed a greater efficiency than acarbose in the inhibition of α-amylase. On the other hand, they demonstrated a mild inhibition effect against *Staphylococcus aureus* and *Fusarium oxysporum*.



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1. Introduction

Many plants and herbs represent potential sources of natural antioxidant and antimicrobial agents for food and medicinal uses in both ancient and modern medicine (Erdemoğlu et al. 2006; Narayanaswamy and Balakrishnan 2011; Bhalla et al. 2013). Thus, the discovery of new sources of safe and inexpensive antioxidants of natural origin is urgently required (Saeed et al. 2012). This increase in demand leads to the augmentation of studies on new natural antioxidants.

Ononis L. is a large genus of perennial herbs and shrubs of the Fabaceae family (Ozenda 1958), represented by 86 species. These are distributed in the Canary Islands, Mediterranean region, North of Africa, North of America, and from Europe to Central Asia (Mezrag et al. 2013; Fayed et al. 2019). The *Ononis* species are known as rich sources of phenolic derivatives (Barrero et al. 1994; Abdel-Kader 2001; Mhamdi et al. 2015) and have shown several pharmacological properties such as antioxidant, antimicrobial, anti-inflammatory and anti-diarrheal activities (Süntar et al. 2011). *Ononis alba* Poir (*O. alba*), alike others *Ononis* species, plays an important role in the balance of the natural environment and in the fight against desertification. It is also used in the traditional medicine of Algeria to treat various diseases such as jaundice, urinary tract infections, herpes and skin disorders (Hamza 2019).

To our knowledge, very few studies have been made on this species. A GC/MS analysis was carried out to characterize the chemical profile of the essential oil obtained from the aerial parts of the plant. The abundancy of phenolic compounds in some other *Ononis* species such as *O. angustissima* Lam. (Mezrag et al. 2017) and *O. natrix* L. (Mhamdi et al. 2015) lead us to carry out some analyses using extracts of this unexplored species (*O. alba*). It is well known that plant extracts rich in polyphenols have shown an antioxidant capacity which can be determined by several methods. The antioxidant activity assessment of *O. alba* extracts obtained with different solvents (*n*-butanol, dichloromethane and ethyl acetate) was performed using two methods (DPPH and CUPRAC). The inhibitory activity of these extracts was also investigated *in vitro* against two different enzymes (α-amylase and α-glucosidase) as an approach to minimize the post prandial hyperglycemia and its complications (De Fronzo 1999; Chiasson et al. 2002). Finally, the antimicrobial properties were evaluated against *Staphylococcus aureus*, *Escherichia coli* and *Fusarium oxysporum* using the well diffusion method.

2. Result and discussion

2.1. Chemical composition of O. alba essential oil

The result of the GC-MS analysis of *O. alba* essential oil is reported in the Table S1 (Supplementary material). Eighty-five compounds were identified. Ketones represented almost 45.1% of the essential oil, with 2-undecanone (30.5%) as the major compound, followed by 2-tridecanone (9.6%) and 2-dodecanone (2.1%).The analysis also showed a large amount of carboxylic acids (17.9%) such as decanoic acid (5.5%), hexadecanoic acid (3.1%), dodecanoic acid (3.0%) and tetradecanoic acid (2.5%). Aldehydes, alkanes and alcohols accounted for 1.8, 1.1 and 0.5%, respectively. Terpenoids gave a minor

Table 1. Total phenolic and flavonoid contents and antioxidant activity using the DPPH and CUPRAC assays of *O. alba* extracts using the DPPH and CUPRAC assays.

Extracts	TPC (mg GAE/g extract)*	TFC (mg QE/g extract)*	DPPH assay IC_{50} (μg/ml)	CUPRAC assay $A_{0.5}$ (μg/ml)
ethyl acetate	NA	10.89 ± 0.44	95.87 ± 3.58	53.06 ± 3.49
dichloromethane	129.0 ± 10.19	98.26 ± 8.91	661.66 ± 6.89	338.3 ± 10.96
n-butanol	197.43 ± 5.69	343.79 ± 7.13	12.09 ± 1.02	15.53 ± 1.32
BHA[b,c]			6.14 ± 0.13	5.35 ± 0.71
BHT[b,d]			12.99 ± 0.41	8.97 ± 3.94
α-tocopherol[b]			13.02 ± 5.17	NT[e]

[a]IC_{50} and $A_{0.5}$ values represent the means ± SD of three parallel measurement ($p < 0.05$).
[b]Reference compounds.
[c]Butylhydroxyanisole.
[d]Butylhydroxyltoluene.
[e]Not tested.
*Values were expressed as means ± SD of three parallel measurements.
NA: not active.
GAE: Gallic acid equivalent.
QE: Quercetin equivalent.

contribution (9.3%), with 0.2% of monoterpene hydrocarbons, 1.6% of oxygenated monoterpenes, 1.0% of sesquiterpene hydrocarbons, 2.1% of oxygenated sesquiterpenes and 4.5% of oxygenated diterpenes. Long chain aliphatic methyl ketones such as 2-undecanone and 2-tridecanone have shown effective repellency properties comparable to synthetic repellent against mosquitoes such as *Anopheles gambiae* (Innocent et al. 2008).

Although several studies have been done on many species of the genus *Ononis*, to the best of our knowledge, no previous reports on the chemical composition of *O. alba* essential oil have been provided so far. (Hamza 2019) reported the results of the analysis by GC-FID and GC-MS of the volatile compounds extracted by HS-SPME with a CAR/PDMS fiber of the aerial parts of some Algerian medicinal plants. The latter study showed that the *O. alba* headspace was composed of 33 volatile compounds, mainly from the aldehydes class. (Ghribi et al. 2016) identified 45 components by GC-MS in the essential oil of *O. angustissima*, with a high proportion of oxygenated sesquiterpenes (33.2%), apocarotenoids (10.3%) and sesquiterpene hydrocarbons (6.3%), with α-eudesmol (22.4%), 2-tridecanone (9.3%) and acetophenone (7.4%) as the main compounds. (Khallouki et al. 2002) discovered that the essential oil of *O. natrix* L. was composed of 26 compounds among which 54% of mono- and sesquiterpene hydrocarbons, and 17.1% of oxygenated terpenes, being camphor (16.2%) and (*E*)-caryophyllene (9%) as the main compounds.

2.2. Total phenolic and flavonoid content

The results of TPC and TFC reported in Table 1 indicated that *O. alba* is a rich source of phenolic and flavonoid compounds. The *n*-butanol extract (197.43 mg GAE/g and 343.79 mg QE/g for TPC and TFC, respectively) exhibited the highest values of flavonoids and polyphenols compared to the one obtained with dichloromethane (129.00 mg GAE/g and 98.26 mg QE/g for TPC and TFC, respectively) and ethyl acetate (10.89 mg QE/g for TFC), the latter having a depleted quantity of these constituents.

TPC and TFC displayed in *O. alba* appeared to be higher than those reported in other *Ononis* species (Djeridane et al. 2010; Khacheba et al. 2014; Laoufi et al. 2017; Guettaf et al. 2018) collected from different regions of Algeria. This difference in phytochemicals contents can depend on the selected species, their geographic origin, the harvest period and moisture (Tsao et al. 2003; Yuri et al. 2009). In addition, extraction solvents with different polarities have significant effects on the extracted phenolic compounds (Siddhuraju and Becker 2003; Sultana et al. 2009).

2.3. Antioxidant properties

The results of the antioxidant assays are reported in Table 1. The results from DPPH assay showed that the *n*-butanol extract exhibited the highest activity with a half inhibition concentration (IC_{50}) value of 12.09 μg/ml. The activity displayed by this latter extract was higher than that of the reference compounds BHT and α-tocopherol, with IC_{50} values of 12.99 and 13.02 μg/ml, respectively. The results obtained using CUPRAC method were also compared to those of BHA and BHT. Once more, the *n*-butanol extract exhibited the highest activity, followed by the ethyl acetate extract and dichloromethane extract. These results confirmed the rate of activity of those obtained in the DPPH assay. This activity may be related to the phenolic and flavonoid contents of this extract (Bensouici et al. 2016; Mezrag et al. 2017; Boudjada et al. 2017). Further studies are ongoing to determine the main secondary metabolites of extract responsible for this activity.

2.4. In vitro enzyme inhibition assays

See Supplementary materials.

2.5. Antimicrobial activity

See Supplementary materials.

3. Experimental section

See Supplementary materials.

4. Conclusion

Our findings showed that *O. alba* is a rich source of polyphenols and flavonoids. Besides its highest phenolic and flavonoid content, the *n*-butanol fraction exhibited a better antioxidant activity and α-amylase inhibitory activity than dichloromethane and ethyl acetate extracts. This activity may reflect the presence of valuable secondary metabolites which are worthy of future isolation and structural elucidation. A large number of volatile compounds such as 2-undecanone, 2-tridecanone and (*E*)-phytol with several reported activities like insect repellant and antimicrobial effects have been identified in the *O. alba* essential oil, making it a product with potential interest in the agrochemical, pharmaceutical and cosmetic industries.

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Disclosure statement

The authors declare no conflict of interest.

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