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Full Length Research Paper

Chemical properties of the medicinal herb Kaff Maryam (*Anastatica hierochuntica* L.) and its relation to folk medicine use

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Kaff Maryam (*Anastatica hierochuntica* L.) is believed to be very useful in Arab countries for treating various health disorders. The present research highlights the chemical composition and properties of *A. hierochuntica* L. that may be related to its beneficial effect. Eight minerals (Mg, Ca, Cr, Mn, Fe, Co, Cu, and Zn), the total phenolic content, antioxidant activity, and free radical-scavenging activity were examined in the leaf buds, stem biomass, and root biomass of Kaff Maryam. The plant was found to be a rich source of Mg, Ca, Mn, and phenolic compounds, and had potential antioxidant and free radical-scavenging activities. The findings of the study indicated that the chemical properties of the plant may rationalize its use for the treatment of menstrual cramps, asthma, depression, headache, fatigue, depression, high blood pressure, and infertility problems, and to ease childbirth, as it is used in traditional medicine. Our findings will encourage herbalists to incorporate *A. hierochuntica* L. in the treatment of various disorders, and this herb could be proved useful in the food industry.

Key words: Kaff Maryam (*Anastatica hierochuntica* L.), minerals, phenolic compounds, antioxidant activity, free radical-scavenging activity, traditional herbal medicine.

INTRODUCTION

Anastatica hierochuntica L. is a small, gray winter annual herb that grows to a maximum height of 15 cm, and produces small white flowers. It is found in the arid regions of Saudi Arabia, Egypt, Jordan, Iraq, the UAE, Iran, Israel, Kuwait, and North Africa, and can survive without water for long periods. The herb curls inward under dry conditions, and then emerges from this dormant state when water is available.

A. hierochuntica L. is known as Kaff Maryam in Arab countries, where it is widely consumed as a tea beverage. It is powdered, mixed with honey and taken for the treatment of many conditions, in particular as a remedy for difficult childbirth and uterine hemorrhage (Khalifa and Ahmad, 1980; El-Ghazali et al., 2010). In addition, it is used to treat asthma, gastrointestinal disorders, depression, high blood pressure, indigestion, headache, cold, fever, malaria, epilepsy, fatigue, diabetes, heart disease, and infertility (Batanouny, 1999; Eman et al., 2011). The idea for the present research was generated from the studies of Baliga et al. (2011), Ducat et al. (2011), Vadivel et al. (2011), and Kovacik et al. (2012), who have identified and quantified a number of minerals and phenolic compounds from various plants used for treating health disorders. However, studies available on the chemical properties of Kaff Maryam are limited (El-Ghazali et al., 2010; Nakashima et al., 2010). The present study provides the first comprehensive analysis of the minerals and total phenolic contents, as well as antioxidant and free radical-scavenging activities found in various parts of the *A. hierochuntica* L. plant, and examines the herb's relation to folk medicine use.

MATERIALS AND METHODS

Samples preparation

A. hierochuntica L. plants were purchased from Makkah, Saudi Arabia. After that the plant were separated into leaf buds, stem

Table 1. Instrument settings for flame atomization.

Condition	Mg	Ca	Cr	Mn	Fe	Co	Cu	Zn
Wavelength (nm)	285.2	422.7	359.3	279.6	248.3	240.7	324.8	213.9
Lamp current (mA)	9.0	10	9.0	9.0	15.0	15.0	9.0	6.5
Slit width (nm)	0.2	0.2	1.3	0.4	0.2	0.2	1.3	1.3
Oxidant	Air	Air	Air	Air	Air	Air	Air	Air
Oxidant pressure (kPa)	160	160	160	160	160	160	160	160
Fuel	Air C_2H_2	Air C_2H_2	Air C_2H_2	Air C_2H_2	Air C_2H_2	Air C_2H_2	Air C_2H_2	Air C_2H_2
Fuel pressure (l/min)	2.2	2.2	2.8	2.2	2.0	2.2	2.2	2.0
Calculation mode	Integral	Integral	Integral	Integral	Integral	Integral	Integral	Integral
Calculation time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

biomass, and root biomass. All the plant parts were oven-dried, and then, powdered for uniformity, and stored in an airtight sample jars at room temperature. For subsequent mineral analysis, 50 g of the powder of each individual plant part was converted to ash at 550°C in a muffle furnace, according to Daur et al. (2011).

For determining total phenolic content, antioxidant activity, and free radical-scavenging activity, 50 g of the powder of each individual plant part was extracted in triplicate with distilled water by boiling and stirring for 10 min. Then, the extracts were filtered over Whatman No. 1 filter paper and stored at −80°C until use, as described by Sharma and Gujral (2010).

Minerals analysis

Mineral analysis was performed according to the AOAC method (2010), where 1.0 g of the ash prepared as mentioned earlier was digested with 10.0 ml of concentrated hydrochloric acid in a beaker on a hot plate until the solution was clear; the volume was reduced to 1.0 ml. The solution was filtered through Whatman No. 1 filter paper and then diluted to 10.0 ml with distilled water. A control solution was prepared by heating hydrochloric acid without addition of the sample.

A Hitachi Z-5000 Atomic Absorption Spectrophotometer equipped with a Zeeman background corrector and data processor was used for mineral analysis of the ash and control solutions. Eight minerals (Mg, Ca, Cr, Mn, Fe, Co, Cu, and Zn) were quantified. All functions were set strictly, according to the manufacturer's instructions, by using the flame atomization technique (Table 1). All experimental procedures, ashing, digestion of ash, and measurement of minerals were performed in triplicate, at the minimum.

Total phenolic content

The total phenolic content was determined according to the Folin-Ciocalteu method, as described by Sharma and Gujral (2010). The results were expressed as both micrograms of gallic acid equivalents (GAE) per gram of sample and micrograms of ferulic acid equivalents (FAE) per gram of sample.

Antioxidant activity

The antioxidant activity was measured according to the method described by Benzie and Strain (1999), by using the ferric-reducing ability of plasma (FRAP) assay that is based on the reduction of the ferric-tripyridyltriazine (TPTZ-Fe^{3+}) complex to its TPTZ-Fe^{2+} form in the presence of antioxidants. The reducing power of the extracts was evaluated according to the method described by Yen and Chen (1995).

Free radical-scavenging activity

The free radical-scavenging activity of the extracts for the various plant parts were evaluated using the method described by Aquino et al. (2001), which is based on the ability of the extract to scavenge the stable 2,2-diphenyl-1-picrylhydrazyl (DPPH), resulting in the bleaching of the purple color exhibited by the stable DPPH radical that is measured at an absorbance of 517 nm. Results were expressed as the percentage of inhibition of the DPPH radical.

RESULTS AND DISCUSSION

The results of mineral analysis of the leaf buds, stem biomass, and root biomass of *A. hierochuntica* L. are presented in Table 2. The data shows that the concentrations of Mg, Ca, and Mn in *A. hierochuntica* L. were greater than their concentrations in other medicinal plants reported by Karadaş and Kara (2012). Furthermore, the concentrations of other minerals (Fe, Cu, and Zn) in *A. hierochuntica* L. were also either greater than or comparable to the concentrations in other medicinal plants, as reported by Lokhande et al. (2010) for *Vetiveria zizanioides*, Shirin et al. (2010) for *Withania somnifera*, and Karadaş and Kara (2012) for cinnamon. The minerals Fe, Cu, and Zn have important functions in blood, tissue, and plasma, and are often consumed as supplements, as reported by Agarwal et al. (2011). The medicinal value of *A. hierochuntica* L. may possibly be related to the high concentrations of Mg, Ca, and Mn contained in the plant. Magnesium has a curative effect on more than 300 disorders, including menstrual cramps, asthma, headache, fatigue, depression, diabetes, fibromyalgia, arrhythmia and heart failure, and preeclampsia and eclampsia, as well as in easing childbirth, as reported by Chiladakis et al. (2001), Champagne (2008), Sun-Edelstein and Mauskop (2009), Guerrera et al. (2009), Guerrero-Romero and Rodríguez-Morán (2009), and Chiuve et al. (2011). Calcium is required for bone repair, vascular contraction and vasodilatation, muscle function, nerve transmission,

Table 2. Mineral concentrations in leaf buds and entire biomass of *A. hierochuntica* L.

Test sample	Minerals (ppm)							
	Mg	Ca	Cr	Mn	Fe	Co	Cu	Zn
Leaf buds	8114 ± 4.6[a]	23286 ± 15.2[b]	5.10 ± 0.12[a]	676.5 ± 11.4[a]	2580.2 ± 9.4[a]	1.5 ± 0.08[a]	290.6 ±6.32[a]	37111.6 ± 5.2[a]
Stem biomass	6998 ± 9.5[b]	22954 ± 21.4[b]	4.38 ± 0.10[b]	415.4 ± 8.6[c]	2186.3 ± 5.8[b]	1.4 ± 0.04[b]	143.0 ± 0.03[b]	23241.0 ± 5.5[b]
Root biomass	6475 ± 12.2[b]	28322 ± 44.0[a]	4.51 ± 0.03[b]	597.1 ± 14.2[b]	2138 ± 14.5[b]	1.3 ± 0.10[b]	156.3 ± 0.03[b]	24867.0 ± 8.4[b]

Each value in the table is the mean of three replicates ± standard deviation. Mean values with different superscript letters in the same row differ significantly ($p < 0.05$).

Table 3. Total phenolic content, Antioxidant activity and free radical scavenging activity of Kaff Maryam (*A. hierochuntica* L.).

Test sample	Total phenolic content		Antioxidant activity	Free radical scavenging activity
	GAE[a] (μg/g)	FAE[b] (μg/g)	FRAP (μM $FeSO_4$/g)	[DPPH inhibition (%)]
Leaf buds	2193.1 ± 8.0[a]	1089.4 ± 12.0[a]	2864.8± 36.4[a]	65[a]
Stem biomass	1659.7 ± 16.7[b]	661.0 ± 19.4[b]	1738.5± 51.3[c]	48[c]
Root biomass	1680.5 ± 21.5[b]	662.6 ± 10.3[b]	1987.4± 48.5[b]	58[b]

Each value in the table is the mean of three replicates ± standard deviation, Mean values with different superscript letters in the same row differ significantly ($p < 0.05$), [a] GAE, gallic acid equivalents, [b] FAE, ferulic acid equivalents.

intracellular signaling, and hormonal secretion, as well as for many other metabolic functions, as mentioned by Moyad (2003), Straub (2007), and Lappe et al. (2008). Moreover, Mn plays a role in the formation of connective tissue, bones, blood clotting factors, and sex hormones, and protects against certain types of cancer, as supported by Ansari et al. (2004), Son et al. (2007), and Menezes-Filho et al. (2011).

In addition to being a rich source of important minerals, all parts of *A. hierochuntica* L., especially the leaf buds, were found to be rich in total phenolic content, and to have high antioxidant and free radical-scavenging activities (Table 3). Recently, the phenolic content and the antioxidant and free radical-scavenging properties of natural products have generated tremendous research interest owing to their related anticancer and antimutagenic properties, as well as their protective effects against cardiovascular diseases and their ability to confer decreased risk of certain chronic diseases, as reported by Weichselbaum and Buttriss (2010) and Saura-Calixto (2011).

In conclusion, all parts of the *A. hierochuntica* L. plant were found to be rich in essential minerals and total phenolic, and to have high antioxidant and free radical-scavenging activities. These properties help to explain the therapeutic effect of the plant as an herbal medicine.

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