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Research Article

Mineral content of some famous medicinal plants grown in darab region, Southern Iran

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Abstract

High concentrations of nutrients in medicinal plants may be harmful to humans and animals. Therefore, the aim of this study was to determine the concentration of some macro-nutrients (calcium, sodium, phosphorus and potassium) and micro-nutrients (iron, manganese, copper, and zinc) in five famous native medicinal plants grown in the rangelands of the Darab region, southern Iran. The concentrations of micro-nutrients, calcium and magnesium, were obtained by atomic absorption spectrometry, sodium and potassium by flame photometer, and the concentration of phosphorus by spectrophotometer in the extract obtained from the dry combustion method and dissolved in 2 N HCl. The results showed that the variation range in the concentration of measured elements was wide. The studied medicinal plants contained significant amounts of calcium (0.325-1.925%), phosphorus (0.096-0.266%), and potassium (0.188-4.312%). The highest concentrations of iron (517.45 mg kg^{-1} DM) and copper (11.8 mg kg^{-1} dry weight) were observed in Maryam nokhodi (*Tecurium persicum*). The greatest concentrations of zinc (22.5 mg kg^{-1} DM) and manganese (200.75 mg kg^{-1} DM) were observed in Shekar shapha (*Otostegia persica*) and Konar (*Ziziphus spina-christi*) plants, respectively. The content of micronutrients in the studied medicinal plants (except copper) was higher than the standard limit reported by the World Health Organization (WHO) for edible plants. Finally, in the case of excessive and continuous consumption of these medicinal plants, harmful side effects are not far from expectation. The amount and time interval of the studied medicinal plant consumption must be done according to the opinion of medicinal plant experts.

Key words: Medicinal plants, Nutrients, World Health Organization, Iron, Copper

Introduction

Medicinal plants play an important role in traditional medicine and are widely used as home remedies. A recent study by the World Health Organization (WHO) found that about 80% of the world's population still relies on traditional medicine for their basic health needs. Therefore, it can be safely assumed that a major part of traditional therapies involves the use of plant extracts or their active principles (Anal and Chase, 2016).

The therapeutic properties of medicinal plants depend on the presence of active compounds in them that are responsible for important physiological functions in living organisms. Micro-nutrients (iron, manganese, copper and zinc) and macro-nutrients (calcium, magnesium and potassium) play a significant role in the reactions that cause the generation of active compounds (Serfor-Armah *et al*., 2001). It is proven that many metabolic disorders and consequent human diseases can be controlled by medicinal plants that are traditionally consumed. The elemental composition of medicinal plants, such as micro and macro-nutrients affects the recovery rate of people as a result of their consumption (Shirin *et al*., 2010). However, it is widely known that if the content of nutrients in medicinal plants to be above the standard limit, not only will their consumption not cure people, but they may cause toxicity. Therefore, knowledge about nutrients concentration are essential to determining the effectiveness of medicinal plants in the treatment of various diseases (Anal and Chase, 2016; Saraf and Samant, 2013).

The flora of Iran has more than 7500 plant species, and many of them are called medicinal plants (Ghorbani and Ahmad Abadi, 2013). Fars Province due to the diversity in topography and climatic conditions in each region, there are a variety of medicinal plants with special genetic diversity, so large quantities of medicinal products are exported to European countries (Boostani *et al*., 2018). Although the medicinal characteristics of these herbal products are widely known, information is scarce in related to their metallic

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Table 1. Scientific name, local name, family and medicinal uses of investigated medicinal plants.

Scientific name	Local name	Family	Medicinal uses	Ref.
Tecurium persicum	Maryam Nakhodi Darabi-Kalporeh	Lamiacae	*T. persicum* is a plant with very potent anti-tumor activity and antioxidant activity	Tafrihi *et al*. (2014)
Peganum harmala	Esphand	Zygophyllaceae	the most important constituents of this plant are beta-carboline alkaloids such as harmalol, harmaline, and harmine	Moloudizargari *et al*. (2013)
Fagonia bruguieri	Esphand Rome	Zygophyllaceae	Anti-inflammatory and wound healing activity	Alqasoumi *et al*. (2011)
Ziziphus spina - christi	Konar	Ramnaceae	Traditional and anti-allergic treatment Therapeutic effect and antioxidant potential of essential oil	Papari Moghadam Fard *et al*. (2020)
Otostegia persica	Shekar Shapha (Goldar)	Lamiacae	The active pharmacological components of *O. persica* most studied are flavonoids and terpenoids	Asgarpanah and Mohammadi (2013)

Figure1. A picture of the studied medicinal plants in this study.

Figure 2. The geographical location of Darab region in Fars province, Sothern Iran

composition. Therefore, it is essential to assess the elemental composition of medicinal plants.

Finally, according to the above, the aim of this study was to characterize the concentration of some macro (calcium, sodium, phosphorus and potassium) and micro (iron, manganese, copper, and zinc) nutrients in five native medicinal plants grown in the rangelands of the Darab region located in Fars province, southern Iran, which are widely consumed by indigenous people as traditional drugs, and compare it with the allowable concentration reported by the WHO (Organization, 2007) for edible plants.

Martials and methods

Collection and preparation of medicinal plants: *Tecurium persicum*, *Peganum harmala*, *Fagonia bruguieri*, *Ziziphus spina-christi* and *Otostegia persica* were collected from the rangelands of the Darab region, Fars province, southern Iran, as the studied medicinal plants. The local names of these plants were Maryam Nokhodi, esfand, esfand roomi, konar and shekar shapha, respectively. Each plant sample was compositely collected from a specific location with five replications. Botanical identification and verification were performed at the College of Agriculture and Natural Resources of Darab, Shiraz University, Iran. The scientific name, local name, family name and medicinal use of these plants are given in Table 1.

The collected samples (edible parts) were first washed with ordinary water to remove any contamination and then kept in an oven at 65 °C for 48 hours to dry. Oven-dried samples were pulverized by an electrical mill and transferred to the laboratory for measuring the concentrations of macronutrients (Ca, Na, P and K) and micronutrients (Fe, Mn, Cu, and Zn). The photos of these studied medicinal plants are shown in Figure 1. The geographical location of Darab region is also shown in the below map (Figure 2).

Elemental analysis of medicinal plants: At first, 0.5 g of the powdered medicinal plants were weighted and immediately placed in an electric oven at 500 °C for 2 hours until they turned to ash. After that, 5 ml of 2 N HCl was added to the resulting ash in the steam bath and kept there for 10 minutes. The acid-digested ash is then made up to 50 ml with distilled water (Ding *et al*., 2016). The concentration of micro-nutrients (iron, manganese, copper and zinc) in the extract was measured by atomic absorption spectrometry (PG 990, UK). Sodium, potassium and calcium concentrations were measured by a flame photometer (Corning 510, UK). Phosphorus content was also determined by the ascorbic acid-molybdate procedure (yellow method) by spectrophotometer (Spectronic, $20D^+$, U.S.) at a wave length of 460 nm. The actual amount of phosphorus was calculated using a standard curve developed using the known standards of K_2PO_4.

Statistical analysis: All determinations were replicated five times, and results were reported as mean values. Data were analyzed statistically according to a completely randomized design using MSTATC software, and means were compared using the least significant differences (LSD) test (Russell, 1986).

Results and discussions

Information on the content of macronutrients and micronutrients in medicinal plants is very important because many of them play an effective role in the formation of active ingredients in the production of herbal medicines. In addition, some of these nutrients are vital for various metabolic processes in the human body (Pytlakowska *et al*., 2012). In this study, the concentrations of different macronutrients and micronutrients, including calcium, sodium, phosphorus, potassium, iron, manganese, copper and zinc, in the medicinal plants were measured. The average concentrations of micro and macronutrients in plant shoots are shown in Table 2.

The results showed that the concentration of each nutrient in one plant species was different from another (Table 2). Changes in nutrient concentrations are attributed to differences in the botanical structure and soil mineral composition in which the plants grew. Also, rainfall amount, soil moisture content and temperature conditions are effective factors in causing changes in plant nutrient content (Sulaiman *et al*., 2017).

Potassium: Adequate potassium concentration in plants is essential for many activities, such as enzyme activation, photosynthesis, water use efficiency, starch synthesis, and protein synthesis. Potassium is also needed to regulate heart rhythm and improve constipation in humans (Martin, 1985). The required amount of potassium for the human body is 3.2 mg day^{-1} (Baysal, 2002). Potassium concentrations in the studied medicinal plants ranged from 0.188% dry matter (DM) (*Ziziphus spina-christi*) to 4.312% DM (*Peganum harmala*) (Table 2). Potassium concentration in all the studied plants is at the desired level, and our results are consistent with previous research on medicinal plants (Jabeen *et al*., 2010; Ozcan and Akbulut, 2008). Mahender *et al*. (2014) reported that the potassium content of *Coriandrum sativum* grown in Pakistan rangelands was 1.4% DM, while that of *Raphanus stivus* was about 0.8% DM.

Phosphorous: Phosphorus is a major component of the structure of intracellular fluids, phospholipids, NAD and NADP coenzymes, and other high-energy compounds. This element contributes to the process of ossification through the deposition of calcium in the form of calcium phosphate (Indrayan *et al*., 2005). In this study, the maximum concentration of phosphorus was associated with *Ziziphus spina -christi* (0.266% DM), and the minimum concentration was attributed to *Otostegia persica* (0.096% DM) (Table 2). Bhowmik *et al*. (2008) reported that the phosphorous concentrations in the medicinal plants *Allium sativum* and *Terminalia belerica* grown in the rangelands of Bangladesh were 11.45 mg kg^{-1} DM and 5.15 mg kg^{-1} DM, respectively. It seems that the studied plant species have a high ability to absorb phosphorus from the soil because the phosphorus content in the studied medicinal plants is much higher than the medicinal plants investigated by other researchers in other areas.

Calcium: Calcium is an important element in the formation of bones, teeth, the muscular system and heart function. Calcium is also essential for the activation of pancreatic lipase (Brody, 1994) .Calcium concentration

Table 2. Total concentration of essential nutrients in the studied medicinal plants (n=5).

Scientific name	K (%)	P (%)	Ca (%)	Na (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})	Zn (mg kg^{-1})
Tecurium persicum	0.69±0.01^{c}	0.18±0.01^{b}	0.34±0.03^{c}	715±5 ^{d}	517±8 ^{a}	54.2±1 ^{c}	11.8±0.9 ^{a}	14.9±0.1 ^{c}
Peganum harmala	4.31±0.6 ^{a}	0.17±0.01^{b}	0.76±0.05^{b}	6400±10 ^{a}	202±4 ^{d}	139±2 ^{b}	11.4±0.7 ^{a}	19.3±0.4 ^{b}
Fagonia bruguieri	0.42±0.01^{d}	0.10±0.01^{c}	0.84±0.01^{b}	985±6 ^{c}	158±6 ^{e}	42.4±0.9^{d}	5.50±0.1^{c}	4.50±0.09^{d}
Ziziphus spina - christi	0.19±0.01^{e}	0.27±0.01^{a}	1.92±0.2 ^{a}	510±8 ^{e}	341±7 ^{b}	200±3 ^{a}	9.85±0.3^{b}	14.7±0.1 ^{c}
Otostegia persica	2.35±0.1 ^{b}	0.10±0.01^{c}	0.32±0.02^{c}	1250±7 ^{b}	276±2 ^{c}	40.7±1 ^{d}	4.95±1 ^{c}	22.5±0.2 ^{a}
Maximum permissible concentration of trace elements for edible plants (WHO, 2007)	--	---	--	--	20	2.0	3.0	27.4

Numbers with the same letter in each column are not statistically significant (P<0.05).

was high in all the studied medicinal plants. The range of calcium concentrations in the studied medicinal plants was between 0.325 to 1.925% DM (Table 2). The highest calcium concentration was observed in *Ziziphus spina-christi* (Table 2). In a study, the amount of calcium content in *Ocimum basilicum* was reported to be about 1.5% DM (Daniel *et al*., 2011). The results showed that the studied medicinal plants contain an appropriate amount of calcium, which is consistent with the findings of other researchers (Gjorgieva Ackova *et al*., 2011; Imelouane *et al*., 2011).

Sodium: Sodium promotes better absorption of simple sugars and amino acids, which are components of starches and proteins. Sodium regulates body water and is effective in regulating the body's pH (Soetan *et al*., 2010). The minimum amount of sodium required for the human body is 2.4 g day^{-1} (Baysal, 2002). The greatest sodium concentration was observed in *Peganum harmala* (6400 mg kg^{-1} DM) and the lowest sodium concentration was attributed to the *Ziziphus spina-christi* (510 mg kg^{-1} DM) (Table 2). The sodium concentration in the leaves of *Achyranthes aspera* was about 158 mg kg^{-1} DM (Saraf and Samant, 2013). It seems that the sodium concentration in the studied medicinal plants was significantly higher than that of other researchers.

Iron: Iron is an essential component of hemoglobin and is present in various human enzymes. High levels of iron are present in red blood cells and muscle tissue. High doses of iron can cause liver toxicity. Iron deficiency leads to anemia, the most well-known eating disorder (Gupta, 2014). In the studied pharmacological plants, iron concentration varied from 517.45 mg kg^{-1} DM in the *Tecurium persicum* to 158.45 mg kg^{-1} DM in the *Fagonia bruguieri* (Table 2). The permissible concentration of iron reported by the WHO (Organization, 2007) for edible plants is 20 mg kg DM. Therefore, based on that, its concentration in the studied medicinal plants is much higher than acceptable limit. The findings of Saraf and Samant (2013) are also consistent with our results regarding the amount of iron in *Achyranthes aspera* Linn.

Manganese: Manganese makes enzymes that oxidize cholesterol and fatty acids. Manganese deficiency can cause bleeding disorders, while high levels can cause speech problems, leg cramps and encephalitis (Al-Fartusie and Mohssan, 2017). The manganese concentration in the studied medicinal plants ranged from 40.75 mg kg^{-1} DM (*Otostegia persica*) to 200.75 mg kg^{-1} DM (*Ziziphus spina-christi*), which was much higher than the critical level reported by the WHO (2 mg kg^{-1} DM) for edible plants (Organization, 2007) (Table 2). The results obtained by Khattak (2013) in relation to measuring the concentration of trace elements in seven medicinal plants, especially thyme (*Tymus vulgare*) in the Balochistan region, are consistent with our findings.

Copper: Excessive copper intake can lead to liver damage and Wilson's disease. Wilson's disease results from the accumulation of free copper in the liver, brain and kidneys (Brima, 2018). Copper deficiency can cause aneurysms, damage to blood vessels, hernias, and nosebleeds (Araya *et al*., 2006). Copper concentration was lower than other studied nutrients in the medicinal plants (Table 2). The lowest concentration of copper was 4.95 mg kg^{-1} DM in relation to *Otostegia persica* and the highest concentration was associated with the *Peganum harmala* (11.45 mg kg^{-1} DM) (Table 2). The permissible concentration of copper in edible plants is 3 mg kg^{-1} DM (Organization, 2007). Therefore, the copper content in all studied medicinal plants was higher than the acceptable limit provided by the WHO.

Zinc: Zinc is an essential nutrient for human health. Ensuring adequate levels of zinc intake should be a key component in efforts to reduce child illness, enhance physical growth and decrease mortality in developing countries. It is used to control the enzymes that operate and renew the cells in our bodies. The formation of DNA, the basis of all life on our planet, would not be possible without zinc (Bhowmik *et al*., 2010). Zinc concentration varied from 4.5 mg kg^{-1} DM for the *Fagonia bruguieri* to 22.5 mg kg^{-1} DM for the *Otostegia persica* (Table 2). The permissible limit of zinc concentration in edible plants has been reported by the

WHO as 27.4 mg kg^{-1} DM (Organization, 2007). Therefore, the amount of zinc in the studied medicinal plants is less than the allowable limit provided by the WHO.

Conclusions

The macronutrient content (except sodium) of all the medicinal plants was at a sufficient level. Furthermore, the content of micronutrients in the studied medicinal plants (except copper) was higher than the standard limit reported by the WHO for edible plants. Finally, in the case of excessive and continuous consumption of these medicinal plants, harmful side effects are not far from expectation. The amount and time interval of the studied medicinal plant consumption must be done according to the opinion of medicinal plant experts. It is suggested that in future research, the concentrations of heavy elements such as cadmium, lead and arsenic in these plants should be measured and compared with the allowable limit in edible plants. In addition, the relationships between soil nutrients and their uptake by medicinal plants should be investigated.

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