Annals of Plant Sciences 7.9 (2018) pp. 2418-2422

ANNALS OF PLANT SCIENCES
ISSN: 2287-688X
OPEN ACCESS
www.annalsofplantsciences.com

Research Article

A comparative study on elemental composition in some wild and cultivated medicinal plants

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Received: 07-04-2018; **Revised:** 12-06-2018; **Accepted:** 23-07-2018

Abstract: An evaluation of elemental composition in medicinal plant is important because mineral contents may be the source of a pharmacological effect. Four elements (Na, K, Mg and Zn) were analysed in wild and cultivated medicinal plants such as *Andrographis paniculata*, *Vitex negundo* and *Solanum surattense*. The present study revealed the presence of minerals such as Na, K, Mg and Zn in all the studied medicinal plants grown in both wild and domestic condition. The presence of those elements indicates the medicinal value of the studied plants. The results show that the cultivated medicinal plants contain more concentration of all the four investigated elements when compared to medicinal plants collected from wild area.

Keywords: *Andrographis paniculata*, *Vitex negundo*, *Solanum surattense*, minerals.

Introduction

The dependence on indigenous medicinal plants for treatment is particularly observed in developing countries where modern medicine is often too expensive therefore out of reach of the majority of the population (Carillon, 2009). Medicinal value of the plant is due to presence of a variety of phytochemical and elemental composition. Therefore, it is essential to investigate the phytoconstituents, elements and vitamin supplements present in the medicinal plant to assess their medicinal values.

Determination of mineral elements in herbal infusions is important to judge their nutritional value and to prevent any probable ill-effects (Karak and Bhagat, 2010). Traditional Indian medical herbs used for strengthening the body immune system are known to have many essential and nutritional elements. Their excess or deficiency may disturb normal biochemical functions of the body (lyengar, 1989).

Most studies on such medicinal plants pertain to their organic contents, viz. essential oils, glycosides, vitamins, alkaloids and other active components and their pharmacological/therapeutic effects. Besides several organic compounds, it is now well established that many trace elements play a vital role in general well-being as well as in the cure of diseases (Underwood, 1997). Hence, Estimation of the element composition of herbal medicines is essential for understanding their health effects and nutritive. The quality of medicinal plants is due by the geochemical features of the soil, the capacity of plants to accumulate nutrients, environmental pollution and fertilization (Queralt *et al*., 2005).

Subramanian *et al,* 2012 studied sodium (Na), iron (Fe), magnesium (Mg), manganese (Mn), lead (Pb), zinc (Zn), cadmium (Cd) and copper (Cu) content in some medicinal plants regularly used in cooking in Indian and showed that the mineral and metal contents in the samples were found at different levels. A total of nine elements (Zn, Cu, Fe, Cr, Ca, K, Li, Mg and Na) were determined in the *Urtica diocia, Taraxacum officinale, Robinia pseudoacacia* and *Matricaria recutita*. All the elements were accumulated to greated to lower extent by all four plants species studied Gjorgieva, *et al*., 2011).

Agarwal, *et al*., 2014 investigated the element (major and trace) present in the leaves by inductive coupled plasma mass spectroscopy against salt standard and showed that the leaves of *Andrographis paniculata* in wild and cultivated form are rich in chemical constituents. Elemental analysis of *Andrographis paniculata* leaves has shown that the plant is a rich source of K, Ca, Mg, Fe, Al, and Na which can play vital roles in health and treatment of diseases. There is little variation in concentration in both cultivated and wild forms.

In India, around 20, 000 medicinal plants have been recorded recently. 500 traditional communities cure the different disease (Chin *et al*., 2010). *Andrographis paniculata* is a one of the wonderful medicinal plant, commonly known as "king of bitters". The leaves and stems of the plant are used to extract the active phytochemicals. The extract of the plants contains diterpenes, flavonoids and stigma sterols (Siripong *et al*., 1992). The whole plant of the *Andrographis paniculata* has medicinal valuable compounds.

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Approximately 28 species of *Andrographis paniculata* are known and indigenous to Asia.

A perfect example of medicinal plants credited with innumerable medicinal qualities validated by modern science and used since ancient times is *vitex negundo*. The genus consists of 250 species of which about 14 species are found in India and some have commercial and medicinal importance. It is commonly known as five-leaved chaste tree is used as medicine fairly throughout the greater part of India and found mostly at warmer zones and ascending to an altitude of 1500m in outer Western Himalayas (Wealth of India Raw materials, 1976).

Solanum surattense is a perennial herb and is considered as one of the most useful traditional medicine in India. The plant medicinally used to treat for cough, asthma and rheumatism. Phytochemical investigation of the *Solanum surattense* reported to have number of alkaloids, sterols, saponins and flavonoids, glycosides and especially it has high concentration of solasodine, a starting material for the synthesis of cortisone and sex hormones. Pharmacological activities such as antibacterial and antifungal, antinociceptive, antioxidant, hypoglycaemic and larvicidal have been reported in this plant.

The main aim of the present study is to compare the mineral nutrients of wild and cultivated medicinal plants of three different species.

Material and Methods

Study plants

***Andrographis paniculata* (Burm.f.) Wall. ex Nees., (Acanthaceae)**

It is an annual, branched, herbaceous plant erecting to a height of 30-110 cm in moist shady places. The stem is acutely quadrangular; much branched and can be broken easily due to its fragile texture. Leaves are simple, opposite, glabrous, lanceolate, 2-12 cm long, 1-3 cm wide with acute entire margin. Inflorescence is terminal and axillary in panicle, 10-30 mm long with small bract and short pedicel. The flowers possess calyx with 5 sepals which are small and linear. Corolla tubes are narrow, about 6 mm long, bilabiate, upper lip oblong, white with a yellowish top, whereas the lower tips are broadly cuneate, 3-lobed, white with violet markings. Stamens 2, inserted in the throat, anther basally bearded. Ovary superior, 2-celled with exerted style. Capsule of the herb is erect, linear-oblong, 1-2 cm long, compressed, longitudinally furrowed on broad faces with thin glandular hairs. Seeds are very small.

***Vitex negundo* L. (Verbenaceae)**

Vitex negundo is a woody, aromatic deciduous shrub growing to a small tree. It is also known as the five-leafed chaste tree or monk's pepper. It is an erect, 2-5 m in height, slender tree with quadrangular branchlets. The leaves have five leaflets palmately arranged, which are lanceolate, acute, glabarous, 4-10 cm long, hairy beneath and pointed at both ends. The terminal leaflet has a long petiole whereas, the lateral ones have short petiole. Flowers are bluish purple in colour borne on axillary or terminal panicle upto 30 cm long. The fruit is succulent globose, and black when ripe with four seeds, rounded and about 4 mm in diameter.

***Solanum surattense* Burn.F. (Solanaceae)**

It is a very prickly, perennial diffuse, patch forming herb, flowering herb flowering and fruiting throughout the year. Leaves ovate-elliptic to oblong, pinnatifid, sinuate, stellate, hairy when young segments ovate irregularly dentate; flowers violet, in 2-6 flowers cymes; calyx lobes ovate-lanceolate, acuminate, glandular within; corolla lobes acute, stellate-hairy, glandular at top; style glabrous; fruits globlse, green white mottled, 1.2-2cm in diameter, seeds glabrous, .

Sample collection

The above said three medicinal plants were collected from wild areas in Tenkasi, Tirunelveli district, Tamilnadu. Their seeds were collected carefully and were allowed to germinate and grown in pots with good garden soil and irrigated properly. The leaves collected from wild and pot cultivated plants were shade dried and ground to coarse powder with the help of electrical grinder and stored in air tight pocket for further analysis. The powdered materials were directly used for analysis.

Determination of Na, K, Zn and Mg

To the powdered plant sample, 5ml of 65% HNO_3 was added and then the mixture was boiled gently for 30-45 minutes. After cooling, 2.5ml of 70% $Hclo_4$ was added and the mixture was gently boiled until dense white fumes appeared. Later the mixture was allowed to cool and 10ml of deionised water was added followed by further boiling until the fumes were totally released (Hseu, 2004). The contents were allowed to cool and then filtered through what man No_4 filter paper in a flask. The filtrate was diluted to 50ml with deionised H_2O and stored for further analysis.

Analytical procedure

Na, K, Mg and Zn in plant samples were analysed using atomic absorption spectrometer (AA-7000) equipped with flame furnace. The absorption wavelength for the determination of each mineral together with its linear working range and correlation coefficient of calibration graphs are given in Table 1)

Table 1. Operating parameter of AAS for studied elements

Elements	Wavelength	Lamp intensity (mA)	Silt width (nm)	Correlation coefficient (r)
Na	589.0	12	0.2	0.999 1
K	766.5	10	0.7	1.000 0
Mg	285.2	8	0.7	0.999 9
Zn	213.9	8	0.7	0.999 6

Results and Discussions

The data obtained are shown in Table 2. Herbs, not only provide us chemicals of medicinal value but also nutritional minerals and trace elements (Zafar *et al.*, 2010). Trace quantities of these elements are essential for enzyme catalyzed biological processes. These elements are made available to human beings by the plants. Hence, their presence is vital for the health and to heal various diseases.

Table 2. Concentration of minerals in leaves of Wild and Cultivated medicinal plants (in ppm)

Name of the Plants	Wild				Cultivated			
	Na	K	Mg	Zn	Na	K	Mg	Zn
Andrographis paniculata	79.9379	306.5876	380.8179	8.9104	112.1726	488.0258	691.0696	9.6462
Solanum surattense	6.9378	319.9305	73.5562	56.9961	82.5950	327.7866	383.2099	61.2325
Vitex negundo	59.4503	160.9383	23.6815	52.0908	71.4772	282.6453	142.4479	64.1311

The present study revealed the presence of minerals such as Na, K, Mg and Zn in all studied medicinal plants grown in both wild and domestic condition. The presence of this elements indicates the medicinal value of the studied plants. The results show that the cultivated medicinal plants contain more concentration of Na, K, Mg and Zn when compared to medicinal plants collected from wild area. This shows that plants accumulate and assimilate several elements from soil. This is because the plants grown in domestic condition get more care through irrigation and manuring.

The presence and concentration of various elements in different plants depend on the composition of soil, water and fertilizers used as well as permissibility, selectivity and absorbability of plants for the uptake of these elements. Hence the observed variation in concentration of the elements is attributed to nature of plants as well its surroundings (Rajukar and Damame, 1997).

The highest more concentration of Na was found in cultivated *Andrographis paniculata* (112.1726ppm), wild *Solanum surattense* (6.9378) has lowest concentration. Sodium is essential to all living organisms. Like Potassium, it is also one of the major electrolytes in the blood. Without sodium the body cannot be hydrated, it would dry off. Na is of great importance for many regulation systems in the body. The minimum daily intake of Na is 2.4 g (Baysal, 2002).

The concentration of potassium is high in both cultivated and wild medicinal plants and varied from 282.6453ppm-488.0258ppm (in cultivated) and 160.9383ppm-327.7866ppm (in wild). Potassium is also an essential macro-element for a human. It is important because it is involved in muscle contraction, in lipids metabolism, in proteins synthesis, maintaining the fluid and electrolyte balance in the body and is responsible in the nerve impulses sending (Mogos, 1997). The necessary daily intake is 2-4 g/day. Potassium has the highest concentration in the leafy materials than other nutrients as it is an activator of some enzymes. One main feature of K is the high rate at which it is taken up by plant tissues. Usually, the absorption of K depends on the soil type.

It is observed that amongst all the elements studied in the analysed sample, Magnesium accumulation is highest in leaves of cultivated (691.0696ppm) and wild (380.8179ppm) *Andrographis paniculata* than the concentration of other elements. *Vitex nagundo* (Wild) contained least amount (23.6815ppm) of Mg. The high concentration of certain metals, Mg^{2+}, K^{+} Ca^{2+} and Fe^{2+} in plants are essential for proper growth and normal functioning of the plant (Underwood, 1971).

Magnesium deficiency in humans caused muscle spasms and has been associated with a high blood pressure, many cardiovascular diseases, diabetes, and osteoporosis. The necessary daily intake is 350 mg/day for men and 300 mg/day for women (Mogos, 1997). Intracellular magnesium deficiency is correlated with the impaired function of many enzymes utilizing high energy phosphate bonds, as in the case of glucose metabolism (Stef, *et al.,* 2010).

It is required in many enzyme-catalyzed reactions, especially those in which nucleotides participate where the reactive species is the magnesium salt, e.g., Mg ATP. It can also prevent some heart disorders and lower blood pressure. Lack of Mg is associated with abnormal irritability of muscle and convulsions and excess Mg with depression of the central nervous system (Prasad, 1981).

Zinc is an essential trace element required for normal growth and a healthy immune system function. It is required for new protein synthesis, DNA replication, RNA transcription, cell division, and cell activation and cell division as well for different chemical reactions (Shankar and Prasad, 1998).

The lowest content of Zn was found in both wild and cultivated medicinal plants. Its concentration

ranged between 9.6462ppm-64.1311ppm in cultivated and 8.9179ppm-56.9961 in wild medicinal plants.

Zinc deficiency is characterized by recurrent infections, lack of immunity and poor growth. Growth retardation, male hypogonadism, skin changes, poor appetite and mental lethargy are some of the manifestations of chronically zinc-deficient human subjects (Prasad, 1982).

Zinc deficiency, particularly in children lead to loss of appetite; grow retardation, weakness and even stagnation of sexual growth (Saracoglu *et al.,* 2009). The maximum tolerable daily intake of Zn is 0.3-1mg/kg (WHO, 1982). The dietary limit of Zn is 100 ppm (Jones, 1987). Except *Andrographis paniculata*, all the investigated herbs were shown to be rich source of Zn in present study.

This present study showed that all the three studied medicinal plants contained minerals like sodium, potassium, Magnesium and Zinc. Consumption of these medicinal plants will result in improved health thereby reducing many diseases like cardiovascular diseases, diabetes, anaemia, rheumatic arthritis, skin diseases, cancers etc. When compared to wild medicinal plants, cultivated plants contain high concentration of analysed minerals. The results strongly supports that the cultivated medicinal plants also have potential and efficacy like the wild plants.

Conclusion

This work attempts to study the mineral composition of wild and cultivated medicinal plants as well as highlighting the efficacy cultivated medicinal plants. The variation in mineral content of studied plants is mainly dependent on the composition of the soil, water, fertilizer and absorbability of plants. This study indicates that some of these plants accumulate certain elements, and this property is exploited by the use of these plants for medicinal purposes in addition to their bioactive secondary metabolites constituents. The elucidation of element specification in these plants helps interpret the therapeutic actions and may help in designing chemically pure medication. In order to link the elemental content and curative power of medicinal plants, there is need to study the effect of soil and other growing condition on the mineral composition of these medicinal plants.

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Cite this article as:

Kamatchi Kala B. & R. Vigneswari. A comparative study on elemental composition in some wild and cultivated medicinal plants. *Annals of Plant Sciences 7.9 (2018) pp. 2418-2422.*

http://dx.doi.org/10.21746/aps.2018.7.9.3

Source of support: Nil.
Conflict of interest: Nil.