Int J Pharm Bio Sci 2015 Oct; 6(4): (P) 40 - 45

Research Article **Natural chemistry**

International Journal of Pharma and Bio Sciences **ISSN 0975-6299**

MINERALS AND HEAVY METALS CONTENTS OF *GLYCYRRHIZA GLABRA* L. AND *ANDROGRAPHIS PANICULATA* (BURM. F.) FROM MEERUT, INDIA

SAMPAT GHOSH* AND MANU SINGH

Department of Biotechnology, Faculty of Biological Engineering, Shobhit University, Meerut-250110

ABSTRACT

The present study was carried out to estimate the level of nutritionally beneficial minerals viz. calcium (Ca), sodium (Na), potassium (K), Magnesium (Mg), iron (Fe), zinc (Zn), copper (Cu) as well as four potential toxic heavy metals namely nickel (Ni), arsenic (As), lead (Pb) and cadmium (Cd) in root of *Glycyrrhiza glabra* L. (Fabaceae) and stem of *Andrographis paniculata* (Burm. f.) Nees. (Acanthaceae). The air dried powdered materials of the useful plant parts were subjected to wet digestion and were analyzed by using atomic absorption spectrophotometer and flame photometer. The result reveals that both the plants may be used as a good source of minerals and very particularly for iron. It also shows that the levels of four toxic metals in both the medicinal plants were below the permissible limit set by world health organization (WHO).

KEY WORDS: ***Glycyrrhiza glabra*, *Andrographis paniculata*, heavy metals, toxicity**

SAMPAT GHOSH
Department of Biotechnology, Faculty of Biological Engineering,
Shobhit University, Meerut-250110
sampatghosh@yahoo.co.in

INTRODUCTION

Plant materials represent a substantial proportion of the global drug market today. Being natural often they receive preference because of low incidence of adverse effect to the synthetic medicines by a major section of population of the world. According to a recent estimate of World Health Organization, 80% of the world population relies on traditional or herbal medicine for their primary health care. *Glycyrrhiza glabra* L. (Family: Fabaceae) commonly known as *mulathee* in India is a perennial plant, geographically distributed to central and south-western Asia and the Mediterranean region and is cultivated in the Mediterranean basin of Africa, in southern Europe and in India[1,2,3]. Contribution of *G. glabra* in traditional as well as modern medicine is well documented. Traditional uses of the plant includes as an expectorant in the treatment of coughs and bronchial catarrh, as a prophylaxis for gastric and duodenal ulcers and dyspepsia[4,5,6], anti inflammatory, as a laxative, contraceptive, anti-asthmatic drug and anti viral agent[7]. Glycyrrhizin, a bioactive compound isolated from the plant has been found the first plant based inhibitor of thrombin and also have been shown to inhibit growth and cytopathology of numerous DNA and RNA viruses including hepatitis A and C, herpes zoster, herpes simplex, HIV and CMV [8]. *Andrographis paniculata* (Burm. f.) Nees. (Family: Acanthaceae) commonly known as *Kalmegh* is an herbaceous annual plant and widely distributed and cultivated in tropical and subtropical Asia, south-east Asia and India[9,10,11]. Andrographolide, the bioactive compound isolated from the plant exerts pharmacological properties like anti-inflammation[9], anti-cancer, immunomodulation[12], anti-hepatotoxic[13,14] and anti-hyperglycemic effects. Though it is a different species (*Glycyrrhiza inflate* Bat.) both the medicinal plants are listed in the Chinese Pharmacopoeia. Although the medicinal properties of these plant are well recognized, the information of their nutritional properties is scanty, may be because they have not received attention as nutrition supplements. However in addition to those active compounds present in these plants these minerals also play important role in promoting health care. Accumulation of toxic industrial effluents including heavy metals in the soil, air and water is continuously increasing due to rapid urbanization and use of pesticides, insecticides etc. is a serious concern today. Plants often accumulate these metals in their harvestable part via root uptake, foliar adsorption, deposition of specific elements in leaves etc. and ultimately transmitted to those organisms including human who ingest them[15]. These heavy metals namely arsenic (As), lead (Pb), cadmium (Cd) are not essential for plant nutrition but often influence elements content of the plant body and have a negative impact in human or animal health[16,17]. Hence WHO advocates quantitative and qualitative estimation of heavy metals of herbal products before use to assure the safety of health. However there are many local vendors those sell the medicinal plant and there is no protocol for the quality control or selling the products. Therefore there is a necessity for the assessment of heavy metals along with the mineral composition in the medicinal plants to understand the nutritional value as well as to ascertain the level of heavy metal contaminants in the plant body.

MATERIALS AND METHODS

Both the plant materials viz. root of *Glycyrrhiza glabra* and the stem of *Andrographis paniculata* were sourced from the local retail vendor of Meerut, India. They were washed thoroughly with running water to remove dust particles. They were shade dried, powdered and stored in closed air tight bottles for further analyses. All the chemicals used in this study were of analytical grade and care was taken that the glassware was meticulously clean. Minerals and heavy metals were estimated following the standard method of AOAC[18]. The powdered plant materials were taken into separate crucibles and were placed in muffle furnace at 500^0C for 6 hours for ashing and cooled in the desiccators. An acid digest of each sample was prepared by oxidizing samples with nitric acid and perchloric acid (2:1) followed by reconstitution of the solution to 20 mL volume with deionized water. Each sample was filtered using Whatman filter paper (0.45µ) and stored in

closed acid washed glass vials and was used to estimate minerals (Ca, Na, K, Mg, Fe, Cu, Zn) and heavy metals (Ni, Cd, As, Pb) by using atomic absorption spectrophotometer (AAS) and flame photometer. The blank and working standards were run followed by the samples. All experiments were carried out in triplicate for precision and accuracy of the results and expressed the results in mg/100g for minerals and mg/kg for heavy metals. The data obtained based on triplicate were subjected to one way analysis of variance where significant difference was discovered.

RESULTS AND DISCUSSION

Mineral content of both the medicinal plants is represented in Table 1. It has been revealed that both the plants are a good source of minerals. Calcium plays important role in bone formation as major proportion of body calcium is located in skeleton by virtue of its phosphate salt. Many neuromuscular and other cellular functions depend on maintenance of Ca^{++} in extracellular fluid[19]. Compared to other minerals calcium is economically relatively inefficient. Following most intakes only about 25-30% of dietary calcium is effectively absorbed and obligatory calcium losses are relatively large (FAO). On the other hand sodium administration raises calcium excretion, presumably because sodium competes with calcium for reabsorption in the renal tubules. *A. paniculata* contained comparatively higher amount of calcium which is comparable if not higher than that of conventional foods of plant origin. Nutritionally significant amount of calcium was present which could be important for pregnant and lactating women, young children at risk of calcium deficiency (and thus, rickets) and postmenopausal women at risk of osteoporosis. Zinc is an essential component of a large number of (>300) enzymes participating in the synthesis and degradation of carbohydrate, lipid, protein and nucleic acids as well as in the metabolism of other micronutrient. It plays a central role in the immune system, affecting a number of aspects of cellular and humoral immunity[20]. Furthermore it plays an essential role in polynucleotide transcription and thus in the genetic expression. *A. paniculata* contained higher amount of zinc than that of *G. glabra*. The sections of a population most at risk for iron deficiency are infants, children, adolescent and women of child bearing age, especially when pregnant[21,22]. The situation with regard to iron supplies is critical in the developing countries including India where these groups do not obtain sufficient iron from their diet[23]. Assuming good bioavailability of the iron content particularly in *A. paniculata* could be regarded as useful in attempt to mitigate the risk of iron-deficiency anaemia. Both the species represent a valuable source of minerals. 100g of the species consumption satisfy the recommended dietary allowance (RDA) for calcium, magnesium and iron (Table 1). The RDA value for pregnant and lactating women is generally higher than the normal women. Both the plant species could satisfy the requirement. *A. paniculata* also may be a good source of copper, satisfying the RDA whereas *G. glabra* could satisfy 62%.

Table 1
Mineral content of Glycyrrhiza glabra and Andrographis paniculata (mg/100g) (Mean±SD) and % of RDA (ICMR 2009)[30] fulfilment

Minerals			*Glycyrrhiza glabra*			*Andrographis paniculata*		
	RDA (mg/day)		mg/100g	RDA fulfilment		mg/100g	RDA fulfilment	
	Male	Female		Male	Female		Male	Female
Calcium	600	600	1297.61±84.75	>100	>100	3967.70±268.19	>100	>100
Magnesium	340	310	693.39±79.00	>100	>100	1675.50±81.86	>100	>100
Sodium	2092	1902	141.42±1.26	6.76	7.44	25.56±2.35	1.22	1.34
Potassium	3750	3225	767.99±4.94	20.48	23.81	1431.91±10.70	38.18	44.40
Copper	1.35		0.842±0.09	62.37		1.670±0.20	>100	>100
Iron	17	21	348.75±22.95	>100	>100	499.03±65.17	>100	>100
Zinc	12	10	0.381±0.00	3.18	3.81	1.260±0.25	10.50	12.6

Table 2
Potential heavy toxic metals content of Glycyrrhiza glabra and Andrographis paniculata (mg/kg) (Mean±SD)

Elements	*Glycyrrhiza glabra*	*Andrographis paniculata*
Nickel	1.40±0.07	8.82±1.31
Arsenic	0.18±0.00	0.93±0.08
Lead	0.29±0.05	4.23±0.50
Cadmium	0.01±0.00	0.07±0.01

Concentrations of potential toxic heavy metals viz. Ni, As, Pb and Cd in these plant parts are represented in Table 2. All the samples were found to contain detectable levels of these heavy metals. These heavy metals contamination may be attributed to many causes including environmental pollution and pesticides. Groundwater arsenic toxicity is a serious public health issue today. Millions of people residing in the Ganges delta in India and Bangladesh are affected by chronic arsenic toxicity which leads to gastrointestinal damage and carcinogenesis of almost all organs[24,25]. Acute arsenic toxicity also leads to encephalopathy and peripheral neuropathy. Trivalent arsenic is more dangerous than pentavalent arsenic. Arsenic exerts its toxicity by inactivating up to 200 enzymes especially those involved in cellular pathways, DNA synthesis and repair[26]. According to Ayurvedic Pharmacopoeia of India the permissible limit for arsenic in the raw herbs in 3 ppm (mg/kg)[27]. Arsenic content of both the plant materials analysed were found below the permissible level. Lead is non essential and highly hazardous heavy metal which leads to toxicity characterized by chronic nephrititis, convulsions, brain damage, central nervous system disorder[28,29]. Unwise use of fertilizer and consumption through food ingestion, fuel combustion and sewage sludge are the main reasons for the escalation of lead pollution. Lead concentration of both the plant was found below the permissible limit of recommended by Ayurvedic Pharmacopoeia of India and world health organization. Although nickel is required in small quantity as it is present in pancreas and plays important role in insulin production and deficiency of nickel results liver disorder, higher amount of nickel leads to toxicity. It has been recognised as allergen by the American Contact Dermatitis Society. Allergic dermatitis because of nickel often known as nickel itch is the most common ailment of it. Furthermore it has been suspected as potential carcinogen and also has an adverse effect on lung and nasal cavities. Nickel content of *A. paniculata* was found 8.82 mg/kg that was higher than that reported for *G. glabra*. However Ayurvedic Pharmacopoeia of India did not prescribe any maximum limit for nickel in raw herbs or finished ayurvedic products and world health organization. Cadmium another non essential trace heavy metal is found to be linked to many adverse changes especially in the arteries of human kidney leading to the kidney failure. It is accumulated in human body replaces zinc biochemically and liver and kidney damage. Cadmium content of *A. paniculata* and *G. glabra* was found 0.07 and 0.01 mg/kg respective which is lesser than that permissible limit prescribed by Ayurvedic Pharmacopoeia of India and world health organization.

CONCLUSION

Both the plant *Glycyrrhiza glabra* and *Andrographis paniculata* is found as a good source of minerals. Consumption of 100g of both of these medicinal plants could satisfy the required dietary allowance for calcium, magnesium and especially iron. Though it is found that none of the heavy metals were present above the permissible limit, initiatives should be taken to establish or strengthen surveillance system to control quality of the medicinal plants and control the non-restricted sell of the plants.

ACKNOWLEDGEMENT

The authors are thankful to Shobhit University, Meerut for providing the facility and Mr. Deepak Kumar for assisting in the analytical works.

Conflict of interest
The authors declare no conflict of interest.

REFERENCES

1. The Indian Pharmaceutical Codex. Vol. 1. Indigenous drugs. Council of Scientific & Industrial Research: New Delhi, 112-113, (1953)
2. S.A. Ghanzafar, Handbook of Arabian medicnal plants.CRC press: Boco Raton, FL, 110-111, (1994)
3. W.Y. Chin and H. Keng, An illustrated dictionary of Chinese medicinal herbs. CRCS Publications: Singapore, (1992)
4. African Pharmacopoeia, vol. 1. 1st ed. Organization of African Unity, Scientific Technical & Research Commission, Lagos, 131-134, (1985)
5. Pharmacopoeia of the People's Republic of China (English ed.), Guandong Science and Technology Press: Guangzhou, (1992)
6. Farmakope Indonesia, 4th ed. Departemen Kesehatan, Republik Indonesia: Jakarta, (1995)
7. P.R. Bradley, Ed. British Herbal Compendium, vol. 1, British Herbal Medicine Association: Bournmouth, 145-148, (1992)
8. Saxena S. *Glycyrrhiza glabra*: Medicine over the millennium. Natural Product Radiance. 4(5): 358- 367, (2005)
9. H.M. Chang and P.P.H. But, Ed. Pharmacology and applications of Chinese material medica. Vol. 1, World Scientific: Singapore, 918-928, (1986)
10. L.D. Kapoor, Handbook of Ayurvedic medicinal plants. CRC Press: Boco Raton, FL, 39, (1990)
11. Medicinal plants in Vietnam. World Health Orgnization, (WHO Regional Publications, Western Pacific Series, No. 3): Manila, (1990). Accessed on 15th April, 2015. http://apps.who.int/medicinedocs/en/d/Js4927e/4.html#Js4927e.4
12. Puri A., Saxena R., Saxena R.P., Saxena K.C., Srivastava V. And Tandon J.S., Immunostimulant agents from *Andrographis paniculata*. J Natural Products, 56: 995-999, (1993)
13. Kapil A., Antihepatotoxic effects of major diterpenoid constituents of *Andrographis paniculata*. Biochemical Pharmacology, 46: 182-185, (1993)
14. Visen P.K.S, Shukia B., Patnaik G.K. and Dhawan B.N., Andrographolide protects rat hepatocytes against paracetamol induced damage. J Ethnopharmacol, 40: 131-136, (1993)
15. Olajire A.A. and Ayodele E.T., Study of atmospheric pollution levels by trace elements analysis of tree bark and leaves. Bull Chem Soc Ethiopia, 17: 11-17, (2003)
16. Chibuike G.U. and Obiora S.C., Heavy metal polluted soils: Effect on plants and bioremediation methods. Applied and Environmental Sol Science, (2014). Accessed on 24th April, 2015 http://dx.doi.org/10.1155/2014/752708
17. Siedlecka A., Some aspects of interactions between heavy metals and plant mineral nutrients. Acta Societatis Botanicorum Poloniae. 64(3): 265-272, (1995)
18. AOAC official methods of analysis (17th edition), Association of Official Analytical Chemists, Washington D.C., (2000)
19. Robertson W.G. and Marshall R.W., Ionized calcium in body fluid. Critical Review in Clinical Laboratory Sciences. 15: 85-125, (1981)
20. Shankar A.H. and Prasad A.S., Zinc and immune function: the biological basis of altered resistance to infection. American Journal of Clinical Nutrition. 68 (suppl): 447S-463S, (1998)
21. Viteri F.E. Iron. Global perspective. In: Ending Hidden Hunger. A Policy Conference on Micronutrient Malnutrition. The Taskforce for Child Survival and Development. Atlanta, Georgia, (1992)
22. Baker R.D., Greer F.R. and the Committee on Nutrition, Clinical Report-Diagnosis and Prevention of iron deficiency and iron-deficiency anemia in infants and young children (0-3 years of age). Pediatrics, 126: 1040-1050, (2010)
23. Rammohan A., Awofeso N., Robitaille M.C., Addressing female iron-deficiency anaemia in India: Is vegetarianism the major obstacle? ISRN Public Health. (2012) doi.: 10.5402/2012/765476

24. Ratnaike R.N., Acute and chronic arsenic toxicity. Postgrad Med J. 79: 391-396, (2003)
25. Chowdhury U.K., Biswas B.K., Chowdhury T.R., Samanta G., Mandal B.K., Basu G.C., Chanda C.R., Lodh D., Saha K.C., Mukherjee S.K., Roy S. Kabir S., Quamruzzaman Q., and Chakraborti D., Groundwater arsenic contamination in Bangladesh and West Bengal, India. Environ Health Perspect, 108: 393-397, (2000)
26. Singh K.P., Bhattacharya S. and Sharma P., Assessment of heavy metal contents of some Indian medicinal plants. American-Eurasian J Agric Environ Sci. 14(10): 1125-1129, (2014)
27. Ayurvedic Pharmacopoeia of India, Department of Ayush, Ministry of Health and Family Welfare, Govt. of India.
28. National Research Council (NRC), Lead in the human environment. Washington DC. National Academy of Sciences. Report No. PB-82-117136. OSTI Identifier: 5455381, ISBN No. 0309030218
29. Hernberg S., Lead poisoning in a historical perspective. American Journal of Industrial Medicine, 38: 244-254, (2000)
30. ICMR, Nutrient requirements and recommended Dietary Allowances for Indian. A report of the Expert Group of the Indian Council of Medical Research, National Institute of Nutrition, Hyderabad, India: (2009)