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ANALYSIS OF MINERAL ELEMENTS OF THE LICHEN *USNEA PICTOIDES* G. AWASTHI BY ICP-OES

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ABSTRACT

Mineral elements have profound influence on human health. In the present study, major and minor elements present in the lichen *Usnea pictoides* G. Awasthi (Parmeliaceae) have been estimated. The powdered lichen was digested with nitric acid in microwave digester. The elemental analysis was done using Inductively Coupled Plasma-Optical Emission Spectroscopic technique (ICP-OES). Among major elements, the content of calcium and magnesium was highest and least, respectively. The content of iron and nickel was highest and least among minor elements estimated. On safety determination, the lichen may be used as a source of important mineral elements.

Key words: Elements, *Usnea pictoides*, Microwave, ICP-OES.

INTRODUCTION

Living beings consume a large number of organic and inorganic compounds to meet the requirements for daily activities. Carbohydrates, fats and proteins are major portion of the diet and are consumed in greater quantity whereas mineral elements and vitamins form comparatively smaller part and are consumed in low quantities. Elements are found essential for the normal functioning of the human body. From the physiological point of view, elements can be distinguished into essential elements that are required for metabolism and life processes and non-essential elements, which are toxic and harmful. Essential elements can be further categorized as major and minor elements based on their requirements. These elements serve as components of enzymes, regulate cellular energy transduction, gas

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transport, antioxidant defense, membrane receptor functions, second-messenger systems and integration of physiological functions. Some 25 elements have been identified as important for maintenance of health; therefore, the estimation of elements in food is of great interest[1-5].

The lichens are symbioses between an alga and a fungus and are self-sufficient and can grow on a variety of habitats such as rocks, roofs, tree trunks etc. Lichens are valuable resources and are used as medicines, food, fodder, dyes perfume, spice etc. Lichens have been used as food traditionally in various parts of the world. Often, lichens were eaten only in times of scarcity and were treated before eating. Lichens are rich in digestible carbohydrates but poor in proteins. Lichens also form a portion of diet for reindeer and caribou in arctic, sub-arctic and alpine-tundra areas of northern hemisphere often constituting >50% of the forage[6-11]. *Usnea pictoides* G. Awasthi (Parmeliaceae) is an endemic fruticose lichen of Western Ghats and is found distributed in Kerala, Karnataka and Tamil Nadu. The lichen grows at high altitudes 1900-2200 m and has an erect, brown corticolous thallus with sympodial branching. Lateral branchlets are sparse, central axis is solid, surface has cracks, hypothecium is colorless, isidea, soredia and apothecia are absent. Iodine test for thallus shows blue color which later turns black. Usnic acid is present[12]. It was found that the elemental analysis of the lichen *U. pictoides* has not been investigated. Hence, the present study focused on estimating the mineral elements in *U. pictoides* by ICP-OES technique.

EXPERIMENTAL

Collection and identification of the lichen

The lichen, growing on the barks of trees, was collected at Mullayanagiri, Western Ghats of Chikmagalur district, Karnataka during the month of June 2012. The place Mullayanagiri is the highest peak in Karnataka, India and is one of the best trekking places in Karnataka and South India. The lichen was identified by morphological, anatomical and color tests[12]. The lichen was shade dried, powdered, extracted with methanol, spotted on the silica plate and developed with solvent system consisting of 180 mL of toluene, 60 mL of 1-4, dioxine and 8 mL of acetic acid to detect secondary metabolites[13]. Usnic acid was present in the lichen.

Estimation of elements by ICP-OES

1 g of powdered lichen was digested in 10 mL of ultrapure metal free nitric acid in a microwave digester (CEM). After digestion, the content was diluted to 25 mL with distilled water. The digested sample was aspirated into ICP-OES (Agilent Technologies 700 series,

US) to estimate major elements *viz*., Calcium (Ca), Potassium (K), Sodium (Na) and Magnesium (Mg) and minor elements *viz*., Manganese (Mn), Iron (Fe), Zinc (Zn), Nickel (Ni), Chromium (Cr), Lithium (Li) and Copper (Cu). The calibration standards were prepared by diluting stock multi-elemental standard solution in nitric acid[14]. Instrument configuration and experimental conditions are given in Table 1.

Table 1: ICP-OES Operation conditions

Parameter	Value
Power (kW)	1.2
Plasma flow (L/min)	15.0
Auxiliary flow (L/min)	1.50
Nebulizer flow (L/min)	0.75
Sample flow rate (L/min)	1.5
Replicate read time (s)	3.00
Instrument stabilization delay (s)	15.0
Sample uptake delay (s)	10.0
Pump rate (rpm)	15.0
Rinse time (s)	10.0
Spray chamber	Cyclonic type
Elements, wavelengths (nm)	Ca (422.673), Cu (327.395), Na (589.592) Cr (267.716), Fe (238.204), K (766.491), Mg (279.553), Mn (257.610), Ni (231.604), Zn (213.857), Li (670.783)

RESULTS AND DISCUSSION

In case of determination of elements in most of the samples, digestion of the samples is necessary. Digestion is done using acids such as HF, $HClO_4$, HCl, HNO_3 and H_2SO_4 in different digestion equipment *viz*., open beakers heated on hot plates, block digesters and digestion units placed in microwave ovens. ICP-OES is a technique used for the determination of elements in various industries. The inductively coupled plasma generates excited atoms, which emit electromagnetic radiation at characteristic wavelengths for a particular element. These atomic emission lines are sharp and can usually be resolved from other elements. In many cases, the technique has replaced flame atomic absorption spectroscopy (with mono-elemental detection) owing to its multi-element estimation capability and relatively high analytical throughput. Accuracy, precision, limit detection and quantification are superior over mono-element detection systems. ICP-OES has been used in aerospace, chemical, environment, food and beverage, geological, pharmaceutical and alloy production industries[4,15-20].

In this study, the elements present in *U. pictoides* have been estimated by ICP-OES technique. A microwave-assisted acid digestion system was used to extract the elements rapidly from the lichen. This microwave extraction was designed to mimic extraction using conventional heating acids. The acid digested lichen sample was subjected to ICP-OES technique in order to estimate the content of 4 major and 7 minor elements. Out of 4 major elements estimated, calcium was detected in high quantity (17087.60 ppm) followed by potassium, sodium and magnesium. Among minor elements, the content of iron was highest (1937.11 ppm) followed by zinc, manganese and others (Table 2). Similar results were obtained for the lichen *Everniastrum cirrhatum* in our previous study, where the contents of calcium and iron were high among major and minor elements, respectively[13]. In another study, high concentration of phosphorus and iron were detected in the lichen *Parmotrema pseudotinctorum*[11].

Table 2: Elemental composition of *U. pictoides*

Element	Content (ppm)
Calcium	17087.60
Potassium	1474.14
Sodium	259.68
Magnesium	240.86
Iron	1937.11
Zinc	83.42
Manganese	36.90
Copper	23.78
Chromium	12.70
Lithium	4.73
Nickel	4.50

CONCLUSION

Elemental analysis reflects the nutritional quality of any food commodity. The results of the present study indicated that the lichen *U. pictoides* was found to contain elements which promote good health as the deficiency of most of these elements is linked with altered health status. The lichen can be used as a source of minerals. Safety analyses have to be conducted in order to recommend the lichen for consumption.

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