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Elemental Analysis in Three Traditionally Important Species of Opuntia in Hyderabad Karanataka Region, India

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ABSTRACT: Present study reveals the presence of 28 elements in fruits and cladodes of three species of Opuntia namely, *O. cochenillifera*, *O. ficus-indica*, and *O. elatior*. The concentration of each element was varied from species to species. The calcium content was found to be more in cladode and fruits of all three species, followed by potassium and magnesium. Among the species, highest of 24.2301 ppm calcium was recorded in cladode of *O. cochenillifera*, followed by 24.149 ppm in *O. ficus-indica* and 23.666 ppm in *O. elatior*. Cadmium, Lead, Mercury, Chromium and Arsenic were detected in traces in cladodes and fruits of all three species. This study will be useful in understanding the nutritive value and therapeutic efficacy of plant material.

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INTRODUCTION

Medicinal plants and herbs are of great importance in health of individual and communities [1]. Mineral elements yield no energy, but they are necessary for several biological essential processes. These mineral elements may be broadly classified as macro (major) or micro (minor) elements based on their daily requirement. The importance of mineral elements is well recognized in human, animal and plant nutrition as their deficiencies/excess in the nutrition can cause a variety of characteristic diseases/disorders. Plant materials form a major portion of the diet and play an important role in nutrition [2-5]. Macroelements, microelements and active constituents of medicinal plants influence on the biochemical processes in human body [6]. Malnutrition is of major concern for many tropical developing countries. Low level of Zn induces the pathogenesis of lung cancer [7]. Breast cancer could develop due to low levels of Ca, Mg, Fe, Cu, Mn and Zn [8].

According to the World Health Organization, the determination of metal concentrations in medicinal plants is a part of quality control to establish their purity, safety and efficacy [9]. The genus *Opuntia* is a xerophytes belongs to family Cactaceae and distributed worldwide with about 200 – 300 species in arid and semi-arid zones. Due to their remarkable genetic variability, the plant shows high ecological adaptation and encountered in places of all climatic conditions [10, 11]. Traditionally, Cactus fruits and cladodes are edible used as vegetable, medicine and in the preparation of cosmetics and natural colours. However, their uses are still mainly restricted to the countries of origin [12-16]. *Opuntia* fruits known as cactus pears or prickly pears are traditionally consumed and also exported to the European market [17, 18]. Recent investigations shows the use of fruit juice as functional ingredient in soft drink and seeds as betalainic colouring foodstuff [19-20].

The Cactus bio molecules have a high potential interest in human health and medicine [21-22]. *Opuntia ficus indica* is known for its high content of polyphenols exhibiting antioxidant and anti-inflammatory properties [23, 24]. The

alkaloids, indicaxanthin, neobetanin, and various flavonoids have been isolated [25] and reported along with the abundant presence of polysaccharides in cladode endowed with antidiabetic and antiglycation effects [26]. The importance of vitamins and minerals of cactus [27] as nutritive [28] antiulcerogenic [29, 30], antioxidant [31–32], anticancer [33], neuroprotective [34], hepatoprotective [35] and antiproliferative agent have been reported [36].

MATERIALS AND METHODS

Study area

Hyderabad Karnataka Region falls under second largest arid zone in India. It consist of 6 districts namely, Bidar, Gulbarga, Yadgiri, Raichur, Koppal, and Bellary situated in the northern part of Karnataka (**Fig.1**) supports for the vast diversity in *Opuntia* sps.

Fig 1. Study area Hyderabad Karnataka region.

Fig.2. *O. cochenillifera* L. (Mill)

Fig.3. *O. ficus-indica* (L.) Mill

Collection and identification of plant material

All the three different sps of *Opuntia* (**Fig. 2, 3, 4**) were collected from different parts of Hyderabad Karnataka Region and identified by referring, Flora of Presidency of Madras, Flora of Gulbarga district and the Flora of Karnataka [37-39]. The cladode and fruits were shade dried, powdered mechanically and made into ash in a crucible of furnace at 65°C for 48h [40].

Fig.4: *O. elatior*

Sample preparation

The elements such as, Cd, Si, Mo, Mg, K, Cr, Al, Ca, Zn, Fe, Ti, V, Cu, Mn and heavy metals of the sample were determined by following the standard method using GBC 932 AA Unicom Flame Atomic Absorption Spectrometer (AAS) at University Scientific Instrumentation Centre, Gulbarga University, Kalaburagi, Karnataka, India. A known amount of sample was digested with the mixture of concentrated sulphuric acid (1:1) and analysed in triplicate (41). The other elements such as Co, Ni, As, Se, Br, Rb, Sr, Zr, Mo, Ag, Sn, Sb, Ba, Au, Pb and Hg were analyzed using X-Ray Florescence (XRF) and K-Shell technologies, providing readings in as little as 2-4 seconds at National Referral Centre for Lead Projects in India, Bangalore.

RESULTS AND DISCUSSION

A total 28 elements such as Cd, Si, Mo, Mg, K, Cr, Al, Ca, Zn, Fe, Ti, V, Cu, Mn, Co, Ni, As, Se, Rb, Sr, Zr, Mo, Ag, Sn, Sb, Ba, Au, Pb and Hg were determined using AAS and XRF. The concentration of each element was varied from species to species. The Ca content was found to be more in all the three species, ranging from 21.793 to 24.2301(ppm) both in cladode and fruits, K ranging from 3.542 to 7.6460(ppm), Mg from 5.556 to 10.382 (ppm), Fe from 1.291 to 3.529 (ppm), Co from 0.039 to 0.056 (ppm), Mn from 0.168 to 4.118 (ppm), Ni from 0.062 to 0.082 (ppm), Zn from 0.133 to 0.517 ppm, As from 0.08 to 0.013 (ppm), Cu from 0.196 to 0.694 ppm, Cd from 0.002 to 0.009 (ppm), Cr from 0.193 and 0.131 (ppm), Pb from 0.001 to 0.009 (ppm), Mo from 0.278 to 471 (ppm) and Se ranging from the 0.712 to 1.238 (ppm).

Knowledge of the elemental content in medicinal plants is very important since many elements play significant roles in the formation of active constituents responsible for the curative properties. Moreover, some of these elements are vitally important for various metabolic processes in human body. They are closely linked to human growth and general health [42]. Calcium content observed in present study was varied from 21.793 to 24.2301ppm with a highest value in *O.cochenillifera* cladode. However, the Ca concentrations reported in the same species from Maxico was between 5.64 to 17.95 [43]. Ca plays an important role in the formation of bones, teeth and heart muscle contraction [44]. It is also required for the coagulation of blood. Excess of Ca in blood may lead to calcification of several internal organs. The deficiency of ion in blood cause disease called 'tetany', osteoporosis, rickets etc. K content ranged from 3.542 to 7.646 ppm with an highest value in *O. ficus indica* fruit. The results are not in favour of the reports in Mexican cultivars (610-720 mg/kg) K regulates acid-base balance in the cell and reduces the blood pressure [45]. It also plays important role in protein synthesis. Mg in *O. ficus indica* fruit is ranged from 3.356 to 10.382. It is required in the plasma and extracellular fluid, where it helps in maintaining the osmotic equilibrium.

Fe content observed in the present study varied from 1.253 to 3.529 with highest value in fruits of *O.ficus indica*. However, very little (0.09 to 0.22 ppm) iron content was reported from Maxico [46]. The dietary limit of Fe in food is 10-60 mg per day [47]. For the formation of haemoglobin iron is necessary. Fe is also required in the process of cellular respiration in human body. Deficiency of iron causes anaemia, depression, poor resistance to infection, weakness etc.

Zn content in present study is in the range between 0.319 to 0.159 ppm as compared to Italian cultivars (0.3 to 0.4 ppm) [48] but very less than the Mexican cultivars (12-16 mg/kg) [49]. Zn is found in more than 200 proteins and enzymes and helps in brain development, DNA synthesis, steroid genesis, bone formation and wound healing. It is a neurotoxin in high concentration. Normal daily intake of Zn is 12-15 mg/day. The permissible limit set by FAO/WHO (1984) in edible plants was up to 27.4 ppm.

Table 1 Concentration of mineral content in cladodes and fruits of three species of *Opuntia in* (PPM)

	Elements	*O. cochenillifera*		*O. ficus-indica*		*O. elatior*	
		Cladode	Fruit	Cladode	Fruit	Cladode	Fruit
1	Cd (Cadmium)	0.002	0.009	0.002	0.004	0.002	0.007
2	Si (Silicon)	0.712	0.731	0.766	1.238	0.768	1.087
3	Mo (Molybdenum)	0.408	0.421	0.322	0.278	0.282	0.417
4	Mg (Magnesium)	3.356	3.412	4.789	10.382	3.686	10.338
5	K (Potassium)	4.953	5.602	4.806	7.646	3.542	7.579
6	Cr (Chromium)	0.235	0.144	0.087	0.036	0.227	0.027
7	Al (Aluminium)	0. 410	0. 400	0.503	0.238	0.648	0. 178
8	Ca (Calcium)	24.2301	22.890	24.149	22.349	23.666	21.793
9	Zn (Zinc)	0.221	0.133	0.319	0.517	0.388	0.426
10	Fe (Iron)	1.253	1.968	1.291	3.529	2.197	2.347
11	Ti (Titanium)	4.470	3.332	4.092	3.272	2.967	3.169
12	V (Vanadium)	1.188	2.278	1.675	1.343	1.861	1.572
13	Cu (Copper)	0.352	0.489	0.196	0.121	0.694	0.394
14	Mn(Manganese)	0.214	0.471	0.230	4.118	0.168	1.467
15	Co (Cobalt)	0.049	0.039	0.051	0.043	0.045	0.056
16	Ni (Nickel)	0.075	0.062	0.079	0.063	0.069	0.082
17	As (Arsenic)	0.009	0.008	0.010	0.009	0.010	0.013
18	Se (Selenium)	0.006	0.005	0.006	0.005	0.005	0.005
19	Rb (Rubidium)	0.020	0.007	0.017	0.021	0.020	0.050
20	Sr (Strontium)	0.196	0.120	0.234	0.083	0.033	0.068
21	Zr (Zirconium)	0.016	0.030	0.019	0.047	0.040	0.015
22	Ag (Siliver)	0.049	0.046	0.051	0.044	0.048	0.055
23	Sn (Tin)	0.080	0.076	0.083	0.070	0.074	0.090
24	Sb (Antimony)	0.088	0.0083	0.092	0.077	0.082	0.0100
25	Ba (Barium)	0.249	0.234	0.286	0.217	0.243	0.311
26	Au (Gold)	0.005	0.004	0.004	0.003	0.004	0.004
27	Pb(Lead)	0.001	0.001	0.001	0.001	0.002	0.005
28	Hg (Mercury)	0.016	0.013	0.013	0.012	0.012	0.016

An Excess of Cu causes dermatitis, hair and skin discoloration etc. It affects some neurological diseases such as Alzheimer's disease, Wilson's disease, Prion disease. Traces of Cu are required for normal synthesis of haemoglobin. Normal daily intake is 2-5 mg per day. In edible plants permissible limit set by FAO/WHO in 1984 was 3.00 ppm. In the present study, the concentration of Cu was between 0.121 and 0.694 ppm.

Cd is non-essential trace element very hazardous to human. It accumulates in the environment and through food chain it causes serious threat such as high blood pressure, kidneys damage and liver problem in human beings. Excess amount causes a disease known as Itai-Itai. The permissible limit set by WHO is 0.2 to 0.81 ppm. Concentration of Cd in all *opuntia* sps is within limits.0.002 to 0.009 ppm.

Pb is nonessential element and has no beneficial effects in humans. Exposure to lead cause abnormal brain, chronic nephritis of kidneys, anaemia, oxidative stress etc. The permissible limit set by WHO is 0.1 to 10 ppm. Concentration of lead in all the sample of *opuntia* is with permissible limit.

Among the species (**Table 1**), *O. cochenillifera* was found better as far as elemental content is concerned, which has highest Ca content followed by *O. ficus-indica*, *O. elatior*. However Cd, Pb and Ar were found in traces in both cladodes and fruits of all three samples. This research is trying to link the content of the element and medicinal values of the *Opuntia* plant. These elements are useful in human physiological activities.

CONCLUSION

The results of present study will be useful in determining the dosage of the drugs prepared from *Opuntia*. The results also support the ethnopharmacological claims of traditional healers and will be helpful in bringing the plant under cultivation in waste land.

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DATA AVAILABILITY

Not declared.

CONFLICTS OF INTEREST

Nil

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