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Review Article
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Metallic Content of One Hundred Medicinal Plants

Waseem Hassan[1]*, Shakilla Rehman[1], Hamsa Noreen[1], Shehnaz Gul[1], Syeda Nida Zainab Kazmi[1,2], Maryam Jan[1], Bakht Zaman[1], Ata Ur Rehman[1], Ziarat Shah[1], Ali Riaz[2] and Imdad Ullah Mohammadzai[1]

[1]*Institute of Chemical Sciences, University of Peshawar, Peshawar -25120, Khyber Pakhtunkhwa, Pakistan*
[2]*Department of Chemistry, Sarhad University of Science and Information Technology, Peshawar -25120, Khyber Pakhtunkhwa, Pakistan*

Abstract

Heavy metals are necessary for the normal functioning of cells and the survival of organisms. These are required for physiological and biochemical functioning of the body, but at higher concentration they causes the oxidative damage. In fact non-essential metals like (lead (Pb), mercury (Hg) and cadmium (Cd)) are more noxious even at very low concentration. It's important to note that heavy metals are present in soil, air and water can easily enter into the organisms. Literature highlighted the role of metals like chromium (Cr), iron (Fe), nickel (Ni), copper (Cu), cadmium (Cd), lead (Pb) and arsenic (As) in oxidative damage. Fenton chemistry/Haber-Weiss reaction are most extensively studied mechanisms by which heavy metals produces reactive oxygen and nitrogen species (ROS and RNS) and ultimately causes oxidative stress. Both redox-active and inactive metals can diminish cellular antioxidant system specifically thiol- containing enzymes and antioxidants and may lead to cellular death. This review will contribute in providing valuable information on metallic contents of selected plants. For the purpose, data has been collected from the literature regarding ten mineral contents (sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), zinc (Zn), iron (Fe), copper (Cu), chromium (Cr), nickel (Ni) and manganese (Mn)) of 100 medicinal plants grown in Pakistan. The metallic contents shows that majority of the plants contain optimum values as compared with daily mineral intake standards. However, several factors may account for variations in mineral concentration, which include soil composition, different geographic areas and environmental changes.

Keywords: Plants; Ethnobotanical uses; Metallic content

Ethnobotanical Uses of 100 Medicinal Plants

Medicinal plants are considered as key sources of drugs for the treatment of various ailments worldwide. The flora of Pakistan due to its highly favorable diverse climatic and soil conditions, many topographical regions and ecological zones offer a great variety of medicinal plants [1]. According to a general survey, approximately 6000 flowering plants exist in Pakistan, out of which 400-600 are utilized for medicinal purposes [2,3]. Literature reported that about 80% of the rural population of Pakistan relies primarily on traditional medicines while 90% of the country's medicinal herbs are imported [4,5].

Furthermore, all the selected plants are utilized by the native people for cure of various diseases such as diarrhea, dysentery, stomach disorders, pain, wounds, skin diseases, scrofula, ulcers, urinary tract infections, bronchitis, asthma, whooping cough, loose motion, emmenagogues, toothaches, rheumatism, sensory and nervous system dysfunctions, sexual disorders, kidney troubles, piles, jaundice, hepatitis, typhoid, malarial fevers, heart diseases and immune deficiency diseases [1-5].

Metallic Content of 100 Medicinal Plants

Mineral elements are assumed of immense value as each of these elements show a distinctive individual role in the structural and functional integrity of the organization of living systems. Although minerals comprise only 4-6% of the human body and do not take part efficiently in fulfilling the energy requirements, yet their importance can be established from their involvement in a large number of physicochemical processes of utmost importance which takes place continuously in living cells and organisms [6,7]. Minerals may be generally classified as macro (sodium (Na), calcium (Ca), phosphorus (p)and chlorine (Cl)) or micro (manganese (Mn), zinc (Zn), iron (Fe), potassium (K), magnesium (Mg), copper (Cu), cobalt (Co) and chromium (Cr)) elements which mostly depend on their requirements to the body and it has been found that approximately more than 100 mg/dl of the macronutrients and less than 100 mg/dl of the micronutrients are necessary on daily basis [6,8]. Deficiencies of the mineral elements are the foremost public health problem in many under developed countries with women and infants at high risk [9]. Studies have shown that severe cases of anaemia most likely due to mineral deficiencies are a direct cause of child and maternal mortality [10].

The medicinal plants serve as a good source of these vital mineral elements which can be consumed both for dietary and medicinal purposes. However the lack of knowledge regarding the mineral quantities in these plants often produce hazardous effects on consumers health as various plants contain toxic metals in sufficient higher amounts. Thus metallic screening of medicinal plants is of immense importance [11]. This review will contribute in providing valuable information on metallic contents of selected plants and both the beneficial and harmful effects of the minerals on human health. For the purpose, data has been collected from literature regarding ten mineral contents (Na, K, Ca, Mg, Zn, Fe, Cu, Cr, Ni and Mn) of 100 medicinal plants grown in Pakistan.

The data concerning sodium (Na) content of the selected medicinal plants have been obtained from the literature and presented in (Table 1). The highest amounts of Na are present in *S.cordifolia* (3.649%) *Z.mauritiana* (34.16 mg/g) and *E.ribes* (12500 ppm). Plants like *D.sisso* (0.07 ppm), *P.granatum* (1.279 ± 0.003 mg/L), *R.communis* (1.64 ppm) and *T.terrestris* (1.70 mg/kg) contain lower amounts of Na, while the

***Corresponding author:** Waseem Hassan, Institute of chemical sciences, University of Peshawar, Peshawar -25120, Khyber Pakhtunkhwa, Pakistan, Tel: 0092-91-9216652; E-mail: waseem_anw@yahoo.com

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Sr. No.	Plant name	Na	K	Ca	Mg	Zn	Fe	Cr	Cu	Ni	Mn
1.	*Terminaliaarjuna*(ppm) [51]		5900	3500	12100	76	750			10	86
2.	*Bauhinia variegate*(mg/kg) [51]			560 ± 40.9	545 ± 50.0	37 ± 2.2	53 ± 1.6				18 ± 0.6
3.	*Cuminumcyminum*(ppm) [52]	0.27	1.81	0.96	0.48	33	229		21		35
4.	*Violaodorata*(ppm) [53]	528	100	78	11.2	2.17	19.4				
5.	*Capsellabursa pestoris*(ppm) [54]					11.4	212	1	4.3	3.1	29
6.	*Allium sativum*(mg/100g) [55]	4.10 ± 0.14	54.00 ± 1.40	26.30 ± 0.14	4.10 ± 0.14	0.34 ± 0.17	5.29 ± 0.08		.001 ± 0.0		0.001 ± 0.0
7.	*Minthaspicata*(ppm)[56]	147.7 ± 4.68	15.56 ± 0.51	255.95 ± 9.01	3.90 ± 0.14	0.79 ± 0.025	2.03 ± 0.052	-	0.88 ± 045	-	-
8.	*Trigonellafoenum*(ppm) [54]	270	50	88	11	2.24	14.2				
9.	*Euphorbia tirucalli*	-	-	-	-	-	-	-	-	-	-
10.	*Cyperusrotundus*	-	-	-	-	-	-	-	-	-	-
11.	*Saussureaelappa*	-	-	-	-	-	-	-	-	-	-
12.	*Fumariaindica*	-	-	-	-	-	-	-	-	-	-
13.	*Solanumnigrum*(mg/kg) [57]	810.77 ± 57.69			185.92 ± 6.12	8.53 ±0.29	311.88 ± 5.02		17.471 ± .84		98.43± 3.67
14.	*Zizyphusjujoba* (mg/100g)[58]	6.21 ± 0.24	375 ± 6.3	45.6 ± 2.1		0.47 ± 0.06	6.42 ± 0.12		0.42 ± 0.02		51.2 ± 2.8
15.	*Eugenia aromatic* (ug/g) [59]	2409 ± 81.60	1618 ± 135.6			4.94 ± 1.228	60.03 ± 0.785	0.96 ± 0.109	3.24 ± 0.261	0.7 ± 0.082	57.3 ± 6.826
16.	*Glycyrrhizaglabra*(mg/100g) [60]	63.20 ± 0.56	180.48 ± 0.12			00.96 ± 0.01	08.08 ± 0.02				
17.	*Piper longum*	-	-	-	-	-	-	-	-	-	-
18.	*Crocus sativus* (mg/100g)[61]	25.75 ± 0.01	542.13 ± 0.01	486.25± 0.12	2.93 ± 0.02	1.80 ± 0.13	17.99 ± 0.09		0.87± 0.008		
19.	*Pipernigrum*	-	-	-	-	-	-	-	-	-	-
20.	*Tagetesminuta* (ppm) [53]	208	80	109	11.5	2.33	14.3	ND	ND	ND	ND
21.	*Thymuslinearis*	-	-	-	-	-	-	-	-	-	-
22.	*Carumcarvi* (mg/kg) [53]	0.1	44.5	11.8	3.1	22.3	74.7	0.3	5.2	59.8	ND
23.	*Menthapiperata* (mg/kg) [62]			12150	3602	12.64	531.5	5.41	11.5		70.8
24.	*Acaciamodesta* (ppm) [63]	1.8	19000			10.2			3.4		
25.	*Nigella sativa*(mg/kg) [64]	0.35 ± 0.02	0.83 ± 0.01%	9.13 ± 0.16	10.20 ± 0.09	0.05 ± 0.00	0.26 ± 0.02		0.03 ± 0.00		103.9 ± 3.69
26.	*Acacia nilotica* (ppm) [65]	87.25	549	2.08	2.075						
27.	*Adhatodavasica* [66]		2000 ppm	20900 ppm	20500 ppm		1250				67
28.	*Psidiumguajava (mg/1oog) [67]*	750.9	895	172	158.7	1.84	11.71		1.38		1.38
29.	*Cassia fistula* (%) [68]	118.4	838	925	947.4	70.67	179.5				37.2
30.	*Cannabis sativa* [69]	-	-	-	-	2.25 ± 0.01 mg/l	135.20 ± 0.12 mg/l	-	26.6 ± 0.01 mg/l	-	40.30 ± 0.05
31.	*Allium cepa* (mg/100g) [70]	5.4	140	22	20	2	0.2	-	-	-	-
32.	*Phoenix dactylifera*(mg/100 g) [71]	3.49 ± 0.12	624 ± 5	81.9 ± 1.9	60.9 ± 1.2	0.45 ± 0.02	0.60 ± 0.11	0.01 ± 0.02	0.77 ± 0.03		0.30 ± 0.04
33.	*chenopodium album* (ppm) [72]	375	10455	4242	45460	0.2	102.8	1.8	4.3	0.3	
34.	*Abutilon indicum* (mg/100g) [73]		261.01 ± 0.01	237.32 ± 0.03	176.50 ± 0.052	1.94 ± 0.03	3.13 ± 0.10				
35.	*Zanthoxylumarmatum* (m/100g) [74]	5.84 ± 2.09	87.84 ± 8.34	96.78 ± 6.86	9.80 ± 2.61	0.032 ± 0.012	0.425 ± 0.02	ND	6.34 ± 2.69		0.043 ± 0.017
36.	*Citrus limon*(mg/100g) [75]	755.50 ± 0.058	8600.00 ± 0.028	8452.50 ± 0.050	1429.50 ± 0.008	13.94 ± 0.007	147.65 ± 0.068		4.94 ± 0.012		
37.	*Sidacordifolia* (%) [76]	3.649	10.2	13.1		5.163	1.135	1.31	8.9		1.86
38.	*Corriandrumsativum* (ppm) [77]					59.4	150.4	<0.003	41.4	<0.006	
39.	*Ricinuscommunis* (ppm) [78]	1.64p	0.79	3.21	0.19	0.49	4.1	3.41	5.2		0.92
40.	*Lepidiumsativum*(mg/100g) [79]	12.4	85.3	8.2	31.8	1	1.1		0.1		0.3
41.	*Sesamumindicum* (mg/kg) [80]	122.50 ± 4.21	851. 35 ± 3.44	415.38 ± 3.14	579.53 ± 0.42						

42.	***Curcuma longa* (mg/kg) [81]**	210	7940	0.12	0.28	57.06			5.71		429
43.	***Grewiaoptiza* (%) [82]**	0.15	0.64	3.35							
44.	***Valerianawallichii*(ppm) [83]**					11.64 ± 0.11	140.8 ± 0.17	266 ± 0.12	11.28 ± 0.06		6 ± 0.05
45.	***Tribulusterrestris* (mg/kg) [84]**	1.7	55	28	32						
46.	***Origanumvulgare* (mg/100g) [85]**	47.2	1970	164	80.67	1.5	17.26	0.26	0.58	0	0.77
47.	***Daturastromium* (mg/g) [75]**	2.5	2.5	295	307.5	0.51	5.63	2.85	8.07		8.49
48.	***Swertiachirata* (ppm) [86]**					45.4			9.8		
49.	***Punicagranatum* (mg/L) [87]**	1.279 ± 0.003	55.19 ± 0.021	1.650 ± 0.00	3.721 ± 0.001	0.430 ± 0.001	0.466 ± 0.003		0.231 ± 0.003		0.033 ± 0.002
50.	***Cedrusdeodara* (mg/100g) [88]**		0.06	2.6	0.017						
51.	***Hippophaërhamnoides* (ppm) [54]**	-	-	-	-	8.1	87	0.4	4.5	4	122
52.	***Menthalongifolia***	373.1 ± 0.40	8372 ± 16	2810 ± 10	3350 ± 13	0.84	0.12 [69]	0.51	0.58 [69]		0.25
	(µg/g)./ mg/l)±SD	[89]	[89]	[89]	[89]	[69]					[69]
53.	***Juglansregia* (mg/100 g) [90]**	0.25 ± 0.02 [91]	3.02	0.79	0.51	3.19 ± 0.85 [91]	5.88 ± 1.10 [91]	0.85 ± 0.44 [91]	3.12± 1.48 [91]	*	10.45± 5.12 [91]
54.	***Plantago ovata* (ug/g) [72]**	1200 ± 60	1000 ± 60	1600 ± 80	63.5 ± 10.5	99.4 ± 10.8	21.7 ± 4.8	11.754 ± 0.01	59 ± 7.3	0.0213 ± 0.0001	6.0 ± 1.2
55.	***Berberislyceum* [92]**	14.5± 0.11 mg/100 g	161.42 ± 0.41 mg/100 g	18.272 ± 0.212 mg/100 g	0.541% [93]	27.50 mg/ kg [93]	2649.99 mg/ kg [93]		33.50 mg/ kg [93]		58.67 mg/ kg [93]
56.	***Withaniasomnifera* (%) [94]**	0.54	2.2	0.16	0.184	44.1 ppm	349.5 ppm	4 ppm [95]	33 ppm	7 ppm [95]	59.0 ppm
57.	***Dalbergiasisso* [13]**	0.07 ± 0.02	2.4 ± 0.70	64.5 ± 1.60	7.4 ± 0.50	*	1.5 ± 0.10	*	*	*	0.03 ± 0.01
58.	***Pyruspyrifolia*** (mg/100 g) [96]	4	96	9	7	0.09	0.29	-	0.05	-	0.03
59.	***Vernoniaamygdalina* (mg/100g) [97]**	-	-	-	0.43 ± 0.00	0.04 ± 0.01	0.14 ± 0.01	0.04 ± 0.01	0.10 ± 0.00	-	0.07 ± 0.03
60.	***Trachyspermumammi* (ug/g) [98]**	-	-	-	-	80.6 ± 24.1	2792 ± 304	-	145 ± 27	-	771 ± 11
61.	***Caricapapaya* (mg/100 g) [99]**	4	223	24.9	23.54	0.056	2.56	-	0	-	0.01
62.	***Citrulluscolocynthis* (mg/100g) [100]**	1.75b ± 0.01	2.85c ± 0.05	1.90b ± 0.01	1.10 b ± 0.02	0.31a ± 0.02	0.10b ± 0.01	*	0.10a ± 0.01	*	
63.	***AzadirachtaindicaA. Juss*(mg/100 g) [101]**	-		-	0.69 ± 0.01 %	0.06 ± 0.01	0.14 ± 0.01	0.58 ± 0.00*	0.06± 0.01*	0	0.06 ± 0.03
64.	***Raphanussativus*(mg/100 g) [102]**	10.7 a**	209 a**	21.0 c**	10.2 b**	0.09 b**	0.73 b**	0.01 c**	0.07 a*	0.07 a**	0.09 b**
65.	***Tamarindusindica*(mg/100 g) [103]**	40.20a ± 0.10	38.93a ± 0.14	454.74c ± 0.13	16.54b ± 0.10	29.60b ± 0.17	27.36a ± 0.60		1.45b ± 0.04		0.20c ± 0.01
66.	***Pisum sativum L* (mg/100 g) [104]**	262 a	756	61	84.06 [105]	3.97 [105]	8				
67.	**Foeniculumvulgare(µg/g) [106]**	69.61 ± 0.532 [59]	9038 ± 571.0 [59]			212.56cd	451.02d	0.53a	37.1 ± 1.220 [17]	9.00b	41.2 ± 1.264 [59]
68.	***Morus alba* (ppm) [107]**	160.65 ± 1.45	0.94 ± 0.02	0.02 ± 0.001	0.04 ± 0.001	20.08± 0. 52	47.90 ± 2.23	<0.006 ± 0.001	1.61 ± 0.01	0.34 ± 0.01	3.95 ± 0.07
69.	***Moringa oleifera* (ppm) [108]**		732 ± 164	602 ± 122	4BDL	BDL	BDL	BDL			
70.	***Ipomoea batatas* (mg/100g) [109]**	4.23 ± 0.02	4.50 ± 0.01	28.44 ± 0.03	340.00 ± 0,.17	0.08 ± 0.00		16.00 ± 0.04	0.00 ± 0.00		4.64 ± 0.10
71.	***Rumexsagittatus* (mg/100g) [110]**	0.177	3	2.31	0.703	39	441		14		80
72.	***Taraxacumofficinale* (mg/100g) [111]**					88 [112]	20.06 ± 0.009	0.08 ± 0.005	1.35 ± 0.02	0.21 ± 0.004	1.79 ± 0.03

73.	***Oscimum sanctum* (mg/100g) [113]**	156	180	45	0.48 to 0.18 [114]	74.7	36.6		3	10.2	
74.	***Oscimumbasilicum*(ppm) [115]**	280 mg/kg [116]	28	17460 mg/kg [116]	34	2.00 to 0.01 [117]	15.15 to 0.20 [117]				2.01 to 0.80 [117]
75.	***Rubusellipticus* (mg/100g) [118]**	-	1.82 ± 0.25	-	5.60 ± 0.15	-	-	-	-	-	-
76.	***Cressacretica* [119]**					55.3-70.2 mg/kg	125.2-151.1 mg/kg		12.2-14.3 mg/kg		24.6-28.9 mg/kg
77.	***Acoruscalamus* (mg/kg) [120]**	-	-	-	-	40.8	-	11.5	26.4	9.6	-
78.	***Citrus sinensis* [121]**	-	-	-	-	-	-	-	-	0.08 mg/kg	-
79.	***Mangiferaindica* (mg/kg) [122]**	-	-	-	-	12.22 ± 3.20	-	0.66 ± 0.12	5.74 ± 0.70	0.06 ± 0.06	-
80.	***Gymnemasylvestre* (mg/kg) [123]**	-	-	-	-	0.0092 ± 0.008	0.0110 ± 0.003	0.2108 ± 0.016	32.8 mg/kg [126]	-	0.0559 ± 0.02 mg/kg
81.	***Eclipta prostrate* (mg/kg) [124]**	-	-	-	-	1.61	23.9	0.47	1.18	-	0 6.97
82.	***Peganumharmala* (ppm) [125]**	148.88 ± 8.16	16176.93 ± 2686.17			32.52 ± 4.28	318.72 ± 36.27	16.36 ± 1.29	18.72 ± 3.24	9.10 ± 2.93	74.60 ± 5.25
83.	***Embeliaribes* % [17]**	1.25%	####			0.05%	0.23%	####	####		####
84.	***Silybummarianum* [126]**	4 mg/kg [127]	2 mg/kg [127]			99.50 mg/kg	360 mg/kg	48.80 mg/kg	27.25 mg/kg	33.75 mg/kg	30.00 mg/kg
85.	***Musa paradisiacal* [128]**	84.53 ppm	3.96ppm			1.01 ppm	27.83 ppm		1.89 ppm	6.10 mg/kg [129]	18.82 ppm
86.	***Woodfordiafruiticosa* (mg/100g) [130]**	500 ± 8.54	150 ± 12.52			1.589 ± 0.14	55.14 ± 0.48		0.640 ± 0.011		1.06 ± 0.11
87.	***Vitesnegundo* (mg/ml) [131]**		1618 mg/ml			2.8 mg/ml	53.3 mg/ml		0.2 mg/ml	0.07 mg/ml	
88.	***Broussonetiapapyrifera* [132]**		9098.7 ± 14.18 mg/kg			29.8 ± 101 mg/kg	414.8 ± 8.23 mg/kg	3.48 ± 0.11 mg/kg	19.75 ± 0.43 mg/kg		44.56 ± 0.76 µg/kg
89.	***Urticadioica* (mg/kg) [133]**					113 mg/kg	432 mg/kg	6.6 mg/kg	14.0 mg/kg	9.1 mg/kg	291 mg/kg
90.	***Verbascumthapsus*(µg/g) [13]**	1624 ± 3.46	6725 ± 1.15			24 ± 1.10	394 ± 2.45	7 ± 0.00	7 ± 1.15	9 ± 1.45	15 ± 0.00
91.	***Malus domestica* [134]**		102.35 ± 0.32mg [135]			3.14 mg/kg		0.144b mg/kg	3.30 mg/kg	0.181b mg/kg	
92.	***Mucunaprurians* (ppm) [136]**					32.48 ± 0.04	33.21 ± 0.03	0.27 ± 0.01	8.43 ± 0.07	3.18 ± 0.02	14.70 ± 0.01
93.	***Tinosporacordifolia (ppm)* [75]**					3.4	37.6		ND	ND ND	
94.	***Stevia rebaudiana*(mg/100g) [137]**	14.93 ± 0.05	21.15a ± 0.35			1.26f ± 0.72	5.89d ± 0.34	1.45 ± 0.01 ppm [138]	0.73g ± 0.002		2.89e ± 0.58 \
95.	***Zingiberofficinale*(mg/100g) [139]**					12.23 ± 0.16	80.00 ± 2.89		12.50 ± 0.29	BDL	7.33 ± 0.22
96.	***Euphorbia hirta* [140]**	-	-	-	-	90.35 ± 70.54	-	-	-	-	-
97.	***Mimosa pudica* (mg/kg) [141]**	-	-	-	-	63.14 mg/kg	-	-	102.31 mg/kg	-	-
98.	***Ziziphus mauritiana* (mg/g) [142]**	34.16mg/g	60.21mg/g	-	-	0.23 mg/g	7.21 mg/g	0.13 mg/g	0.004 mg/g	0.002 mg/g	0.0234 mg/g
99.	***Chenopodiumambrosoides***	-	-	-	-	-	-	-	-	-	-
100.	***Cynodondactylon* [143]**	3.41 _ 0.0159 (g kg-1 DM) [144]	31.6 ± 2.2 mg/kg [145]			259.91 mg/kg	9035.16 mg/kg		190.12 mg/kg	2.58 ± 0.15 mg/kg [146]	659.49 mg/kg

Table 1: Metallic Contents of 100 Medicinal Plants.

mean Na value for all the other plants is projected as ± 1400 mg/kg. The recommended daily minimum intake of Na is estimated as 2400 mg [12]. Na exists as the primary cation in extracellular fluids and is known for regulation of membrane potentials, cell permeability, muscle irritability, conduction of nerve impulses and keeping a constant osmotic pressure [8,13,14]. Hypernatremia results due to excess serum concentration of Na and this has been suggested as a consequence of various factors such as, administration of several hormones, excessive release of adrenocorticotropin in Cushion's disease and diabetes insipidus whereas hypernatremia is reported in diarrhea, vomiting,

severe burns, nephrosis, intestinal obstruction and Addison's disease [7].

The potassium (K) content of the plants ranged from 0.0024 ppm in *D.sisso* to (1618 mg/mL) in *V. negundo*, whereas the average K content of the other selected plants is found as ± 6000 mg/kg. *D.stromium* (295.10 mg/g). *E.ribes* (21.5%), *S.cordifolia* (10.21%), *C.limon* (8600.00 ± 0.028 mg/100g), *W.somnifera* (2.2%), and *A.modesta* (19000 ppm) are also considered as good sources of K as their K values are far more higher than the minimum K daily intake value which is 3500 mg [12]. The importance of K is speculated from its participation in large number of biological processes such as acid base balance, movement of muscles, nerve impulse conduction and regulation of osmotic pressure. K is the major cation present in the intracellular fluid, its reduced concentration has been associated with paralysis, muscular weakness, mental confusions [7,8,14], cardiac arrhythmias, defects in renal functions and carbohydrate tolerance [15,16].

The data obtained from literature (Table 1) revealed the presence of calcium (Ca) in highest concentration in plants like *S.cordifolia* (13.09%) followed by *C.limon* (8452.50 ± 0.050 mg/100 g) and *A.vasica* (20900 ppm), while lowest Ca contents are estimated in *M. alba* (0.02 ppm), *C. longa* (0.12 ppm) and *C.cyminum* (0.96 ppm).The recommended daily Ca intake required for normal biochemical activities of the body is 1500 mg. Ca is known as an indispensible macro mineral for the composition of bones and teeth. Ca deficiency implements rickets and osteomalacia in children and adults, respectively. This may also contribute in the pathogenesis of osteoporosis resulting in weak and porous bones and considerable high risks of fracture [8,11]. Ca plays significant role in membrane permeability and regulates the transmission of nerve impulses, any decrease in the extracellular blood Ca may results in tetany and convulsions, due to impetuous discharges of nerve impulses [17,7,8]. Ca converts prothrombin to thrombin efficiently and thus helps in blood coagulation; it increases the absorption of dietary vitamin D, clotting of milk and activation of enzymes such as lipase, ATPase succinic dehydrogenase. Ca ions normally aids in the strength of cardiac muscles, however excess absorption of Ca may cause Ca toxicity and leads to cardiac failure [18].

Medicinal plants such as *D.stromium*, *C.album* and *A.vasica* contain maximum magnesium (Mg) contents of 307.49 mg/g, 45460 ppm and 20900 ppm respectively. The minimum amount of Mg were found in *D.sisso* (0.0074 ppm), *C.deodra* (0.017 mg/100g) and *R. communis* (0.19 ppm), while the mean Mg quantity present in all the plants is projected as ± 350, which is fairly in comparison with the predicted daily Mg value (400 ppm). Mg is required for teeth, bones, several enzyme systems [8] and for maintenance of osmotic pressure in extracellular fluids and plasma. Mg depletion results in chronic vomiting, diarrhea, vasodilation with erythema and hyperemia. More serious situations have been reported in long term deficiency of Mg such as neuromuscular hyperirritability and cardiac arrhythmia [18,19].

Data obtained from literature concerning the quantity of zinc (Zn) in medicinal plants revealed the presence of considerable higher amount of Zn in *S.cordifolia* (5.163%), *V.negundo* (2.8 mg/ml), *E.ribes* (0.0450%) and *C.limon* (13.94 ± 0.007 mg/100 g), while *G.sylvester*, *C.album, Z.armatum, C.cyminum, P.granatum*, and *R.communis* contain lesser amount of Zn as 0.0092 ± 0.008 ppm, 0.2 ppm, 0.032 ± 0.012 mg/100g, 0.401 ppm, 0.430 ± 0.001 mg/L and 0.49 ppm respectively. The essential Zn value needed on daily basis is 11 mg which is slightly less than the projected Zn content in the mentioned plants i. e. ± 20. The importance of Zn is elucidated from its role as a co-factor for majority of enzymes, performing remarkable functions in living systems such as cell replication and metabolism of nucleic acids and other macronutrients [20-22]. In addition, Zn is considered as an integral component of insulin, a key factor in protein synthesis, wound healing and repairment of tissues [8,23,24]. Decreased amount of Zn is associated with the metabolic disorders, growth retardation, skin abrasion and coronary heart pathologies [18,25].

The occurrence of iron (Fe) in medicinal plants is ranged from a lowest value in *G.sylvestre* (0.0110 ± 0.003 mg/kg) to a quantity as much as high in *V.negundo* (53.3 mg/ml). The suggested mean value for Fe in all the plants is ± 400, while the daily dietary requirements of Fe are 15mg. Fe exists primarily as hemoglobin and transferrin in the erythrocytes and plasma fractions of the blood, respectively. Fe is considered vital in composition of cytochromes, myoglobin, hemoglobin and succinate dehydrogenases as well as a co-factor for enzymes which participate in the synthesis of neurotransmitters [26]. The deficient concentrations of Fe intake have been associated with impairments in brain development and functioning, protein synthesis, restless legs syndrome and organogenesis [27]. Exceeded levels of Fe in various organs and tissues including brain can cause haemosiderosis, type-1 neurodegeneration, Alzheimer's disease and Parkinson's disease [7,8]. The role of Fe in the body is clearly allied with the transfer of oxygen from lungs to the tissue cells and hemoglobin [28] moreover; its lack is the most rampant nutritional deficit in humans and is usually caused by deficient dietary intake [29]. Furthermore, *S.cordifolia* having (1.309%) of chromium (Cr) is considered to be the rich Cr containing medicinal plant, while the minimum Cr concentration was found in *C.sativum* (<0.003 ppm) of all the selected plants for this review. The FAO/WHO estimated permissible value of Cr should not be more than 2 ppm [30] which is in close proximity with the mean Cr content of all the plants, which is ± 4. Cr is an efficient mediator of carbohydrate metabolism and an imperative component of glucose tolerance factor (GTF), which enhances the action of insulin and sustains normal levels of glucose tolerance [8,31]. Cr deficiency leads to hyperglycemia, cataracts and atherosclerosis [32]. The role of Cr in maintenance of the configuration of RNA molecule, protein and lipid metabolism is also known from various animal and human studies [31,33]. Cr toxicity due to its increased concentration in body tissues results in impairment of liver, kidney, blood and nervous system functions and ultimately death [34,35].

The maximum amount of copper (Cu) is present in plants like *S.cordifolia* (8.899%), *W.fruiticosa* (6400 mg/100 kg) and *D.stromium* (8.07 mg/g), whilst *A.sativum* (0.001 ± 0.0 ppm), *N.sativa* (0.03 ± 0.00 mg/kg), and *C.papaya* (0.001 mg/100 g) are considered as lowest Cu containing plants. The daily permissible value of Cu in diet is recommended as 900 mg for children and adults. Cu is an important redox-active element and an indispensible component of various enzyme systems including ceruloplasmin, cytochrome oxidase, cytosolic superoxide dismutase and lactase. Cu facilitates the absorption and incorporation of Fe in hemoglobin, thus regulates hemoglobin synthesis and its deficiency may cause anemia [8,36,37]. Cu is also necessary for the smooth functioning of neurologic and hematologic systems [27]. However, excess amount of dietary Cu accumulates in liver resulting in a decline in blood hematologic concentration and Cu poisoning, which adversely affects the functioning of liver and as a consequence cause jaundice due to erythrocyte haemolysis [18].

Nickel (Ni) is quite low in all the selected medicinal plants ranged from<0.006 ppm in *C.sativum* to 0.07 mg/mL in *V.negundo*. The mean Ni content for all the plants is projected as ± 2 which is comparable to

the WHO recommended value of Ni (1.63ppm) in edible plants [38], also higher amount of Ni is noxious for health [39].

In addition, the absorbance of Ni by the body is very low [40], yet it has been suggested that Ni contribute in the metabolism of nucleic acids, preservation of membrane structure, control of prolactin and act as a key component of enzymes such as plant ureases and several hydrogenases. Also, experimental findings reported the malfunctioning of chicks and rats' liver when fed on Ni deficient diets [41]. Ni is present mostly in the pancreas and helps in regulation of insulin while its deficiency results in liver disorders [42].

Similarly, Manganese (Mn) rich plants include *S.cordifolia* (1.863%), *D.stromium* (8.49 mg/g) and *T.ammi* (771 ± 11 ppm), while *A.sativum* (0.001 ± 0.0 mg/100 g), *P.granatum* (0.033 ± 0.002 mg/L) and *D.sisso* (0.03 ± 0.01 ppm) contain lowest amounts of Mn. Mn is required for several primary biochemical processes as it has been known as an active component of a number of enzymes including decarboxylases, transferases and hydrolyses [8,43]. Literature reported the pharmacological inference of Mn in anticipation and cure of diabetes mellitus [44]. Moreover, the existence of Mn in mitochondrial superoxide dismutase provides an evidence for the involvement of Mn in oxidative phosphorylation reactions. Optimum Mn levels maintain the normal bone structures and regulate functioning of central nervous system (CNS), while reduced amount lead to reproductive failure in both sexes [45], in addition Mn overexposure accounts for drastic effects on CNS and mood [27].

Conclusion

The human body requires a number of minerals in order to sustain good health [48]. Macro and microelements play a significant part in the metabolism, composition of certain proteins (hemoglobin and haemoprotein) and some mineral elements stay chelated with organic ligands and make them bioavailable to the body system [47-49]. The excessive amount of elements or specifically metals can lead to the generation of free radicals and consequently oxidative damage. The current study was aimed to review and compile ethnobotanical uses of 100 medicinal plants (which belongs to 53 families). The selected plants are utilized by the native people for cure of various diseases. The metallic contents of all the plants are presented here, shows that majority of the plants contain optimum values as compared with daily mineral intake standards. However, several factors may account for variations in mineral concentration of a particular plant, which include soil composition, different geographic areas and environmental changes.

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