Myanmar Health Sciences Research Journal, Vol. 29, No. 1, 2017

Accumulative Study of Heavy Metals in Soils, Water and Uptake by Rhizome of Two *Cissus* Species from Various Sites

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The determination of heavy metals in soil, plant and water samples are very important in monitoring environmental pollution. The ability of the plant to absorb heavy metals can cause human health or ecological become worst. The ecological differences have direct or indirect contact to the medicinal plants and they may be regarded as an index of trace metal concentration in the surroundings. The aim of this study was to determine physico-chemical parameters and concentration of heavy metals in soil, water and rhizome of two *Cissus* species from various sites and to make awareness among the public regarding its safer use and collection areas, containing high level of heavy metals and their adverse health effects. The atomic absorption spectrophotometer was employed for content of heavy metals of rhizome of *Cissus repens* Lam. (တပင်တိုင်မြနန်းအနီ) and *Cissus discolor* Blume. (တပင်တိုင်မြနန်းအဖြူ) from Myitkyina, Mogok, Aungban, Pyin Oo Lwin and especially in Shan State. The factors affecting metal accumulation by plant species including metal concentrations, pH, electrical conductivity, and nutrient status in different sites were measured. All rhizomes contained high amount of Ca and Fe than permissible limit set by Ajasa, 2004 (44-614 µg/g) and WHO, 2008 in edible plants (20 mg/kg). Whereas, rhizome of *Cissus repens* Lam. from Myitkyeena contained Mn (364.73 ±73 ppm), Ni (1.51±0.07 ppm) and Moegoke contained Mn (228.35 ±4.76 ppm), Ni (2.16±0.08 ppm) which were above the permissible limit. Most selected rhizomes, all soils and water, from four samples locations contained metals and elements which are within permissible limit. This study revealed that free from toxic contaminant (Cd, Cr and Pb) in soil, water and rhizomes from four different sites were detected. Monitoring of heavy metal distribution data in soil, water and plant samples are very useful for becoming main references or guidelines in order to monitor and avoid environmental pollution become worst in terms of quality of soil and safe level for medicinal plant to be consumed.

Key words: Heay metals, Rhizome of *Cissus* species from various sties

INTRODUCTION

The determination of heavy metals in soil samples, plant samples and also water samples are very important in monitoring environmental pollution. Metals are toxic even in traces. Heavy metals contamination has great significance due to their tendency to accumulate in human organs over a prolonged period of time. The ability of the plant to absorb heavy metals can cause human health or ecological become worst. The ecological differences have direct or indirect contact to the medicinal plants and they may be regarded as an index of trace metal concentration in the surroundings i.e., soil, water and atmosphere. The presence of heavy metals beyond the allowed upper and lower limits can cause metabolic disturbance.[1] *Cissus discolor* Blume. (whole plant) can be used for ringworm in India. *Cissus repens* Lam. (stem juice) is useful in

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eye redness, bone fracture healing property, anti-osteoporotic effect, anti-bacterial, anti-oxidant and anti-inflammatory effect in Nepal and also its root is applied for headache, burns, gastric trouble, rheumatism in India.[2]

Leaves, stems and rhizomes of *Cissus* species can be used not only as oral drug but also as paste form. Paste form of both white and red rhizomes can cure mass, abscess, benign and malignant tumors. Red rhizome is more effective than white rhizome. Gastric cancer can be treated by giving rhizome that is mixed with honey. It can also be used in gynaecological diseases. The leaves can also be applied on wound for healing. Rhizomes of *Cissus* species consist of glycosides and flavonoids.[3] The WHO recommends that medicinal plants which form the raw materials for the finished products may be checked for the presence of heavy metals.[4] The increasing use of indigenous therapies demands more scientifically sound evidence, therefore, this study was aimed to determine the content of heavy metals (cadmium (Cd), calcium (Ca), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn), nickel (Ni), potassium (K), sodium (Na), and zinc (Zn) in soils, water and rhizome of two *Cissus* species from various sites where *Cissus* species have been grown up enormously in Shan State.

MATERIALS AND METHODS

Reagents and chemicals

Analytical grade reagents (Merck) of cadmium (Cd), calcium (Ca), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn), nickel (Ni), potassium (K), sodium (Na) and zinc (Zn) standard were used as standard reference materials, while 70% nitric acid (HNO_3), 69%, hydrochloric acid (HCl) and de-ionized double distilled water (ddw) were used for digestion purpose.

Instruments and apparatus

Atomic Absorption Spectrophotometer (AAS), AA 6650, Shimadzu Japan was used for measurement under the standard operating condition. Muffle furnace (LEF 1035) were used.

Calibration of equipment

For the elements under investigation, the following sensitivity and detection limits were established, respectively for the used AAS apparatus. Cd 0.1 ppm, 0.2 ppm, 0.4 ppm, and 0.8 ppm, Ca 0.5 ppm, 1 ppm, 2 ppm and 5 ppm, Cr 0.5 ppm, 1 ppm, 2 ppm and 4 ppm, Cu 0.5 ppm, 1 ppm, 2 ppm and 5 ppm, Fe 0.5 ppm, 1 ppm and 2 ppm and Pb 1 ppm, 2 ppm, 5 ppm and 10 ppm and Mg 0.1 ppm, 0.2 ppm and 0.4 ppm, Mn 1 ppm, 3 ppm and 5 ppm, Ni 0.5 ppm, 1 ppm and 2 ppm, K 0.2 ppm, 0.4 ppm and 0.8 ppm, Na 0.1 ppm, 0.2 ppm and 0.4 ppm, Zn 0.2 ppm, 0.4 ppm, 0.8 ppm and 1.6 ppm.

Plant authenticity

The plants were identified and confirmed for their specific botanical name by the competent taxonomist from the Department of Botany, Mandalay University (Mandalay).

Sample collection

Rhizome of *Cissus repens* Lam. (တပင်တိုင်မြန်းအနီ) their soil and water samples were collected from Myitkyina (Site I), Mogok (Site II). Rhizome of *Cissus repens* Lam. and *Cissus discolor* Blume. (တပင်တိုင်မြန်းအဖြူ) their soil and water samples were collected from Aungban (Site III) and Pyin Oo Lwin (Site IV). All samples were collected from December to February, 2014.

Both soil and rhizome samples were collected from each site of plants at about 8-10 cm depth of the soil and then the plant rhizome and soil samples were placed in the polyethylene sampling bags. The rhizome samples were thoroughly washed with tap water and rinsed with de-ionized water to remove dust and other particles. The cleaned samples were dried in shade at room temperature. The dried samples were crushed, powdered and homogenized, using mortar and pestle, were kept in polyethylene sampling bags.

Water samples were collected at depth of 20 cm from the water surface directly into one litre pre-conditioned polyethylene bottle.

Digestion of rhizome samples

Specified weight (2.5 g) of crushed and powder portion from each rhizome of *Cissus repens* and *Cissus discolor* was placed into crucible for heating in an oven at 110°C for 2 hours to remove moisture. Then, the dried sample after charring was placed in furnace. The furnace temperature was gradually increased from room temperature to 550°C in 30 minutes. The sample was ashed for about 4 hours until white or grey ash residue was obtained. The content of crucible was cooled in desiccators and weighed. Then, 5 ml of 6M HNO_3 was added to the ash samples of each rhizome to dissolve and digest the contents. The solutions were filtered by Whatmann (No. 42) filter papers, transferred to 50 ml volumetric flasks and diluted with de-ionized water.[5]

Digestion of soil samples

Soil samples were dried in an oven at 110°C for 2 hours until they were brittle and crisp. A portion (1 g) of dried, soil samples were placed separately in 50 cm^3, pyrex beakers, and then digested with 12 cm^3 of a mixture of HNO_3-HCl (in the ratio of 1:3 v/v) to near dryness in an oven at 110°C for 3 hours and cooled. And then 20 ml of 2% HNO_3 were added into these beakers on the hot plate to boil for 10 minutes and cooled. The digested samples were filtered into the 100 cm^3 volumetric flask using Whatmann (no. 42) filter paper and the volumes made up to the marks with double de-ionized water.[6]

Digestion of water samples

Fifty millilitre of water sample were placed in 100 ml beaker. Then, 2.5 ml of concentrated nitric acid were added and covered with watch glass. And then, it was heated for 10 minutes and cooled. After cooling, they were transferred into 50 ml volumetric flask and diluted with de-ionized water for heavy metal analysis.[7]

Analysis of water samples

Physico-chemical parameters like conductivity, total dissolved solids and salinity of the samples were measured at sampling site using Pocket Pro ^{TM} Tester, HACH, China. pH was also recorded at sampling site using Waterproof Handheld (H160), HACH, China, portable pH meter.[8]

Phytochemical test for types of compounds

Preliminary detection of phytochemical compounds present in rhizome of two *Cissus* species from various sites were carried out according to the general methods mentioned in phytochemical methods.[9]

Statistical analysis

Data were analyzed by using Microsoft Excel version 2007. Results were presented as mean±SD.

RESULTS AND DISCUSSION

Plant authenticity

Morphology, taxonomy and anatomy of the plants were observed to agree with the following botanical name; *Cissus repens* Lam. (တပင်တိုင်မြနန်းအနီ) and *Cissus discolor* Blume. (တပင်တိုင်မြနန်းအဖြူ).

Cissus repens Lam. (တပင်တိုင်မြနန်းအနီ)

Cissus discolor Blume. (တပင်တိုင်မြနန်းအဖြူ)

Table 1. Level of heavy/toxic metals (ppm) in rhizome samples from different sites

Metal	Site I	Site II	Site III		Site IV		Reference value
	Cissus repens Lam.	*Cissus repens* Lam.	*Cissus repens* Lam.	*Cissus discolor* Blume.	*Cissus repens* Lam.	*Cissus discolor* Blume.	
Cd	ND	ND	ND	ND	ND	ND	0.3*
Ca	1604.11±31.87	1523.15±18.05	1554.53±6.98	944.08±23.05	2978.93±167.98	1843.13±42.98	44-614**
Cr	ND	ND	ND	ND	ND	ND	2*
Cu	0.38±0.12	ND	5.01±1.08	5.25±0.27	5.27±0.61	5.18±1.05	20*
Fe	284.96±7.63	112.27±4.37	150.51±25.05	101.53±3.95	102.91±3.82	65.89±11.29	20*
Pb	2.28±0.21	1.86±0.36	0.37±0.57	1.15±0.64	2.91±0.73	3.94±1.3	10*
Mg	50.43±0.37	50.03±0.47	49.75±0.3	49.31±0.55	115.29±2.43	58.42±1.89	2000**
Mn	364.73±7.14	228.35±4.76	143.94±2.83	82.08±1.35	23.37±1.36	22.83±1.24	200*
Ni	1.51±0.07	2.16±0.08	0.85±0.03	0.60±0.06	0.43±0.26	0.80±0.06	1.5*
K	721.98±5.33	707.95±18.61	720.43±26.99	437.02±15.62	582.22±12.27	1178.7±19.25	6380-36600**
Na	52.03±0.97	71.51±2.26	81.61±0.74	74.4±1.28	181.52±6.19	93.04±1.40	2610-51340**
Zn	8.64±0.61	3.29±0.3	14.55±2.44	5.59±0.38	7.76±0.55	37.49±6.74	50*

*=Ref: 10, **=Ref: 11, ND=Not detected

Table 2. Level of heavy/toxic metals (ppm) in soil samples of *Cissus* species from different sites

Metal	Site I	Site II	Site III		Site IV	Reference value
	Cissus repens Lam.	*Cissus repens* Lam.	*Cissus repens* Lam.	*Cissus discolor* Blume.	*Cissus repens* & *Cissus discolor*	
Cd	ND	ND	ND	ND	ND	3*
Ca	5090.61±80.36	ND	1019.32±21.78	119.22±2.98	261.57±1.33	52000**
Cr	44.99±1.75	ND	53.71±3.49	12.58±2.0	22.1±2.48	100*
Cu	5.52±1.15	ND	ND	ND	ND	100*
Fe	2610.68±8.14	2668.34±12.34	2403.67±16.39	2521.01±9.35	2493.99±16.34	50000*
Pb	57.1±21.03	33.82±1.2	10.28±2.07	7.62±1.15	16.91±2.63	100*
Mg	160.68±1.35	97.82±0.41	149.56±0.82	144.88±0.68	151.26±1.04	9000***
Mn	1241.42±15.37	466.66±7.51	583.76±8.94	597.32±9.5	924.52±13.25	2000*
Ni	33.77±0.46	13.14±0.44	22.61±0.87	12.27±0.49	16.57±23.31	50*
K	4686.4±34.1	887.26±6.99	1355.14±36.88	549.12±14.39	619.15±12.31	37000***
Na	287.23±4.86	ND	45.49±0.53	31.78±0.44	ND	25000***
Zn	41.63±1.1	28.22±0.73	28.98±0.83	44.32±1.24	14.36±0.42	300*

*=Ref: 12, **=Ref: 13, ***=Ref: 14, ND=Not detected

Phytochemical constituents of rhizome of cissus species from various sites

Carbohydrate, glycosides, phenols, reducing sugar, saponins and starch were present in all *Cissus* species from different sites.

Table 3. Level of heavy/toxic metals (ppm) in water samples from different sites

Metal	Site I	Site II	Site III	Site IV	Reference value
Cd	ND	ND	ND	ND	0.003*
Ca	11.12 ±0.46	29.47 ±1.16	1.11 ±0.04	37.67 ±1.6	75***
Cr	ND	ND	ND	ND	0.05*
Cu	ND	ND	ND	ND	2*
Fe	ND	ND	0.01 ±0.00	0.06 ±0.01	0.3*
Pb	ND	ND	ND	ND	0.01*
Mg	2.30 ±0.03	2.29 ±0.02	0.78 ±0.03	2.06 ±0.04	50***
Mn	ND	ND	0.07 ±0.01	0.11 ±0.00	0.4*
Ni	0.02 ±0.00	0.05 ±0.00	0.02 ±0.00	ND	0.07*
K	0.38 ±0.03	2.82 ±0.26	0.31 ±0.1	1.79 ±0.04	10**
Na	4.65 ±0.04	ND	1.65 ±0.04	1.38 ±0.03	200***
Zn	ND	ND	ND	ND	3*

*=Ref: 15, **=Ref: 16, ***= Ref: 17, ND=Not detected

Cadmium

In studied rhizome, soil, and water samples, **'**Cd' concentrations were not detected in all 4 sites. 'Cd' causes both acute and chronic poisoning, adverse effect on kidney, liver, vascular and immune system.[19]

Calcium

The range of 'Ca' in rhizomes of studied sites was high with a minimum of 944.08±23.05 ppm of white *Cissus* in Site III and a maximum of 2978.93±167.98 ppm of red *Cissus* in Site IV, these values were higher than the maximum allowable limit (MAL) of 44-614 µg/g.[11] For rhizome samples, the WHO (2001) limits have not yet been established for 'Ca'.

The range of 'Ca' in soils of studied sites was a minimum of 119.22±2.98 ppm of white *Cissus* in Site III and a maximum of 5090.61±80.36 ppm of red *Cissus* in Site I, these values were lower than the maximum allowable limit (MAL) of 52000 µg/g.[13] For

Table 4. Level of some physico-chemical parameters for water samples from different sites

Location	Conductivity (μS/cm)		TDS (mg/l)		Salinity (g/l)		pH		Temperature (°C)	
	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range
Site I	315.33±0.58	314.75-315.91	272±0.00	272-272	0.19±0.00	0.19-0.19	6.87±0.21	6.66-7.08	19.37±0.23	19.14-19.6
Site II	292.67±11.02	281.65-303.69	253.67±6.66	247.01-260.33	0.18±0.01	0.17-0.19	7.37±0.68	6.68-8.04	21.17±1.27	19.9-22.44
Site III	31.57±0.64	30.93-32.21	25.07±2.32	22.75-27.39	0.03±0.02	0.01-0.05	8.1±0.1	8-8.2	18.37±0.81	17.56-9.18
Site IV	292.67±9.07	283.58-301.74	256±2.65	253.35-258.65	0.18±0	0.18-0.18	6.43±0.21	6.22-6.64	22.43±1.59	20.82-24.02
Reference value	(300 μS/cm)[17]		TDS<300:Excellent 300-600:Good 600-900:Fair 900-1,200:Poor Above 1200:unacceptable[17]		Non Saline <1 Slightly Saline 1-3 Moderately Saline 3-10 Very Saline >10[18]		6.5-9.2[17]			

Table 5. Physico-chemical parameters for soil samples from four different sites

Location		pH	Temperature (°C)
Site I		7.9	21.7
Site II		7.22	21.8
Site III	*Cissus repens* Lam.	7.79	22.0
	Cissus discolor Blume.	7.55	21.6
Site IV		7.50	22.2
References value		6.5-9.2[17]	

soil samples, the WHO (2001) limits have not yet been established for 'Ca'.

'Ca' concentrations in the studied water samples were ranged from 1.11±0.04 ppm from Site III to 37.67±1.6 ppm from Site IV. Both of them were found to be lower than the permissible limit of 'Ca' set by WHO (1994) in drinking water (75 ppm). Humans need large amounts of 'Ca' for construction and maintenance of bone and normal function of nerves and muscles.[20]

Chromium

'Cr' was not detected in rhizome and water samples collected from all 4 sites. In studied soil samples, **'**Cr' was detected in soil from Site I, Site III and Site IV. Their concentrations of 'Cr' ranged between 12.58±2.0 ppm and 53.71±3.49 ppm, these values were lower than the maximum allowable limit (MAL) of 100 μg/g.[12] **'**Cr' was not detected in soil from Site II. Chronic exposure to 'Cr' may result in liver, kidney and lung damage.[19]

Copper

In studied rhizome samples, **'**Cu' was detected in soil from Site I, Site III and site IV. Their concentrations of 'Cu' ranged between 0.38±0.12 ppm and 5.27 ±0.61 ppm, these values were lower than the maximum allowable limit (MAL) of 100 μg/g (WHO, 2001).[12] **'**Cu' was not detected in rhizome from Site II. In the present study, lower amount for 'Cu' in plant materials collected from Site I, III and IV were found showing no harmful effect of this metal on plant. In studied soil samples, 'Cu' was detected in soil 5.52±1.15 ppm from Site I. Its concentration was lower than the maximum allowable limit (MAL) of 100 μg/g (WHO, 2001).[12] **'**Cu' was not detected in soil from Site II, III and IV.

In studied water sample, **'**Cu' was not detected from Site I, II, III and IV. 'Cu' is one of the essential elements for plants and other living organisms. Fumes of 'Cu' may cause metal fumes fever with flu like symptoms, hair and skin discoloration while dermatitis has not been reported.[21]

Iron

The range of 'Fe' in rhizomes of studied sites was high with a minimum of 65.89±11.29 ppm of white *Cissus* in Site IV and a maximum of 284.96±7.63 ppm of red *Cissus* in Site I, these values were higher than the maximum allowable limit (MAL) of 20 ppm.[15]

The range of 'Fe' in soils of studied sites was high with a minimum of 2403.67 ±16.39 ppm in Site III and a maximum of 2668.34±12.34 ppm in Site II, these values were lower than the maximum allowable limit (MAL) of 50000 μg/g.[12]

'Fe' concentrations in the studied water samples were ranged from 0.01±0.00 ppm from Site III to 0.06±0.01 ppm from Site IV. Both of them were found to be lower than

the permissible limit of 'Fe' set by (WHO, 2008) in drinking water (0.3 ppm).[15] But, 'Fe' concentrations were not detected in Site I and Site II of water samples. 'Fe' is necessary for the formation of haemoglobin and also plays an important role in oxygen and electron transport in human body systems.[19] Excess of 'Fe' can cause haemosiderosis.

Lead

In the studied rhizome samples, 'Pb' concentrations were ranged from 0.37±0.57 to 3.94 ±1.3 ppm and found to be lower than (MAL) 10 ppm.[10] The range of 'Pb' concentration in soil samples in all four sites was from 7.62±1.15 to 57.1±21.03 ppm, these values were within the (MAL) 100 ppm.[12]

In the water samples, 'Pb' was not detected in four different sites. 'Pb' causes both acute and chronic poisoning, and also poses adverse effects on kidney, liver, vascular and immune system.[19]

Magnesium

The content of 'Mg' in the rhizome samples ranged between 49.31±0.55 ppm and 115.29±2.43 ppm in all sites, these values were within the (MAL) 2000 ppm.[11] In the studied soil samples, 'Mg' concentrations were ranged from 97.82±0.41 ppm and 160.68±1.35 ppm in all sites, these values were within the (MAL) 9000 ppm.[14]

In the studied water samples, magnesium in all different locations was found to be within the (MAL), 50 ppm.[17] Mg is the fourth most abundant element in the human body and is essential to be good health.[19]

Manganese

Rhizome of *Cissus repens* Lam. from Site I contains Mn 364.73±7.14 ppm and Site II contains Mn 228.35±4.76 ppm which were above the permissible limit 200 ppm.[10] In the studied soil samples, 'Mn' concentrations were ranged from 466.66 ±7.51 ppm to 1241.42±15.37 ppm, these values were within the permissible limit.

In water samples, 'Mn' was found to be within the permissible limit[15] in Site III and Site IV. Deficiency of manganese in human causes myocardial infection and other cardiovascular diseases, also disorder of bony cartilaginous growth in infants and children and may lead to immunodeficiency disorder and rheumatic arthritis in adults.[4]

Nickel

Rhizome of *Cissus repens* Lam. from Site I contains 'Ni' 1.51±0.07 ppm and Site II contains 'Ni' 2.16±0.08 ppm which were above the permissible limit 1.5 ppm.[10]

In the studied soil samples, 'Ni' concentrations were ranged from 12.27±0.49 ppm to 33.77±0.46 ppm, these values were within the permissible limit 50 ppm.[12]

In water samples, 'Ni' was found to be within the permissible limit 0.07 ppm in all sites.[15] 'Ni' toxicity in human is not very common occurrence because its absorption by the body is very low.[19]

Potassium

In the studied rhizome samples, 'K' concentrations were ranged from 437.02 ±15.62 ppm to 1178.7±19.25 ppm and found to lower than (MAL) 6380-36600 ppm.[11] The range of 'K' concentration in soil samples in all four sites was from 549.12±14.39 ppm and 4686.4±34.1 ppm, these values were within the (MAL) 37000 ppm.[14]

In the water samples, 'K' in all different locations was found to be within the (MAL), 10 ppm.[16] Potassium ions are the most abundant cation in the human body.[19]

Sodium

The content of 'Na' in the rhizome samples ranged between 52.03±0.97 ppm and 181.52±6.19 ppm in all sites, these values were within the (MAL) 2610-51340 ppm.[11]

In the studied soil samples, **'**Na' was detected in soil from Site I and Site III. Their concentrations of 'Na' ranged between 31.78±0.44 ppm and 287.23±4.86 ppm, these values were lower than (MAL)

of 25000 ppm.[14] 'Na' was not detected in soil from Site II and Site IV.

In the studied water samples, 'Na' in all different locations was found to be within the permissible limit 200 ppm.[17] But, 'Na' concentration was not detected in Site II of water samples. The healthy human body contains 90 g to 130 g of Na.[19]

Zinc

In the studied rhizome samples, 'Zn' concentrations were ranged from 3.29 ±0.3 ppm to 37.49±6.74 ppm in four different sites but these values were within the (MAL) 50 ppm.[10]

The content of 'Zn' in the soil samples ranged between 14.36±0.42 ppm and 44.32±1.24 ppm, these values were within the (MAL) 300 ppm.[12]

In the studied water samples, 'Zn' was not detected in four different sites. The general sources of 'Zn' contaminations are agro-chemicals, burning of fossil fuels, sewages. Due to its importance, 'Zn' is present in blood and about 85% of it combines with protein for transport after absorption and its turnover is rapid in pancreas. Deficiency of 'Zn' causes diabetic hyposomia, hypogensia or coma.[21] Zinc toxicity may be acute or chronic. Acute toxicity can cause: abdominal pain, nausea, vomiting and diarrhoea.

The range and the average value, (Mean ±SD), of the physico-chemical parameters including conductivity, TDS, salinity, pH and temperature of the drinking water samples are shown in Table 4.

Electrical conductivity (EC), which is a measure of water's ability to conduct an electric current is related to the amount of dissolved minerals in water, but it does not give an indication of which element is present but higher value of EC is a good indicator of the presence of contaminants such as sodium, potassium, chloride or sulphate. Analysis of the results showed that all the samples from Site II, III and IV have EC values less than the (WHO, 1994) maximum admissible limit 300 μS/cm in Table 4. The range of EC of water samples were from 31.57±0.64 (μS/cm) to 315.33 ±0.58 (μS/cm). Very high values of EC were not detected in studied samples but in Site I was slightly higher EC value 315.33 (μS/cm) than maximum allowable limit.[17]

The palatability of all water samples with TDS level of less than 300 mg/l is greatly considered to be excellent WHO, 1996. Drinking water becomes significantly and increasingly unpalatable at TDS levels greater than about 1000 mg/l. TDS greater than 1200 mg/l may be objectionable to consumers and could have impacts for those who need to limit their daily salt intake e.g. severely hypertensive, diabetic, and renal dialysis patients.[22] According to the salinity classification of all the water samples were found to be non-saline, that is less than one.[18]

pH of the water samples was between 6.43±0.21 (Site IV) and 8.1±0.1 (Site III), pH laying in the normal range, and also pH of all soil samples were within the admissible limit 6.5-9.2.[17] Temperature of the samples was in the range of 18.37±0.81 to 22.43±1.59°C, with minimum value (18.37) from Site III and maximum value (22.43) from Site IV.

According to phytochemical study, the results showed that carbohydrate, glycosides phenol, reducing sugar, saponin and starch were present in both *Cissus* species in all sites.

Conclusion

There have been no own soil, water and plant quality standard in Myanmar yet. Therefore, Myanmar still has to establish soil, water and plant quality standards, the data generated in this study may also be useful as a basis for formulation of standard guideline.

Most of the selected rhizomes, their soils and all water samples from four different locations contained the metals which are within permissible limit and they are

generally safe for use. However, few cases contain more heavy/toxic metals than the permissible limit. The possible reasons to accumulate hazardous metals in plants may include the growing of these plants in contaminated as mineral in soil and rocks of earth such as near mining and industrial areas or irrigated by toxic water. The studied plants were hyperaccumulators even their soil contain the lower elemental level.[23, 24]

This study revealed that free from toxic contaminant (Cd, Cr, Cu, Pb and Zn) in water from four different sites were detected and also all the physico-chemical parameters including conductivity, TDS, salinity, pH and temperature of the drinking water samples are considered within range of permissible level. As a conclusion, monitoring of heavy metal distribution data in soil, water and plant samples are very useful for becoming main references or guidelines in order to monitoring and avoid environmental pollution become worst in terms of quality of soil and safe level for medicinal plant to be consumed.

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