J. King Saud Univ., Vol. 5, *Science* (2), pp. 101–106 (A.H. 1414/1993)

Minerals Content of Wild Plants from Ashafa, Toroba, Wahat and Wehait (Saudi Arabia)

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(Received 9 December 1991; Accepted for publication 2 June 1992)

Abstract. Four desert plant species (*Alhagi maurorum, Peganum harmala, Zilla spinosa, Zygophyllum album*) from Ashafa, Toroba, Wahat and Wehait (Saudi Arabia) were collected and analyzed for heavy metal contents. Aluminium was found in high concentrations in all the plant samples analyzed (shoots and roots), followed by copper, manganese and zinc. The concentrations of A1, Cu, and Mn were generally higher in shoots than in roots, but the concentration of Zn was less in shoots than in root. Slight variations in the concentration of heavy metals were observed in plants from different places.

Introduction

Pollution of plants by heavy metals occurs due to industrial wastes, application of fertilizer, corrosion and burning of coal and wood [1-4]. Chemical, physical, biological and microbiological properties of the soil also contribute to the variability in trace element contents of plants. Pollution of trace elements in the soil affect the production of crops [5-7].

The present study aimed to establish the trace element concentrations of plants from Ashafa, Toroba, Wahat and Wehait. The study has become especially important since pollution resulting from burning Kuwait oil wells after the Gulf War would have increased the heavy metals concentrations in plants of Saudi Arabia. Most important are the biological and health effects on man and animals caused by metal pollution in plants.

Materials and Methods

Alhagi maurorum, Peganum harmala, Zilla spinosa and *Zypoghyllum album* were collected from Ashafa, Toroba, Wahat and Wehait. The geographic locations of these places was mentioned in another article [8]. The plants collected for analysis dominated the vegetation of these localities and are annual herbs.

A detailed analysis of the mineral contents of soils of Ashafa, Toroba, Wahat and Wehait was mentioned earlier [8]. The roots and shoots samples were washed in tap water several times, followed by washing in distilled water to get rid of adherent soil. Plant samples were dired in an oven at 85 °C for 24 hours and 0.5 g of sample (root or shoot) was placed in a 100-ml beaker with 15 ml concentrated nitric acid, covered with a watch-glass and heated at 95-100 °C for 15 min. The digest was made up to 50 ml with deionized water and analyzed using atomic absorption spectrophotometry to determine A1, Cu, Mn and Zn contents (total dry weight). Four plant samples were collected from each place and four replicates of each sample were used for metal analysis.

Results and Discussion

Soils from Ashafa, Toroba, Wahat and Wehait were sandy, low in organic matter and have a neutral reaction (Table 1).

Table 1. Soil analysis of the sampling sites

Locality	Soil type	Organic matter %	pH
Ashafa	Sandy	1.08	7.0
Toroba	Sandy	1.10	7.0
Wahat	Sandy	1.30	7.1
Wehait	Sandy	1.00	7.3

Heavy metals analysis of the shoots of these plants indicated a high aluminium concentration compared to Cu, Mn and Zn. (Table 2). Shoots and roots of plants of one locality varied in the concentrations of metals and variation was also observed in the concentration of heavy metals in one plant collected from different localities (Table 3). Metal concentrations were generally higher in shoots than in roots of the plants.

The concentration of A1 in the plants studied ranged 78-193 ug g^{-1} dry weight of the shoots of plants which is close to the average of 200 ug g^{-1} concentration generally found in the plants (5) although A1 concentration was reported to be as high as 5000 ug g^{-1} in some tea plants [9-11].

Copper in low quantity is required for the good development and growth of plants [5] and is found generally in the range of 2–25 ug g^{-1} [12;13]. However, the

Table 2. Heavy metal (ug g^{-1}) contents in the shoot of plants collected from different localities (n = 4, ± standard deviation)

Locality	Plants	Metals (ug g^{-1})			
		Al	Cu	Mn	Zn
Ashafa	*Alhagi maurorum*	101±3.0	3±0.1	7±1.1	9.0±1.3
Ashafa	*Peganum harmala*	105±3.6	13±1.9	10±1.8	2.0±0.0
Ashafa	*Zilla spinosa*	89±2.9	11±2.1	9±1.0	18±1.9
Ashafa	*Zygophyllum album*	78±1.1	6±0.9	7±1.8	6±0.6
Toroba	*Alhagi maurorum*	110±1.8	5±1.1	6±1.0	11±1.3
Toroba	*Peganum harmala*	115±2.1	11±3.1	4±1.1	6±1.1
Toroba	*Zilla spinosa*	120±3.0	8±1.6	9±0.9	6±0.9
Toroba	*Zygophyllum album*	91±1.1	10±1.2	7±0.9	9±0.3
Wahat	*Alhagi maurorum*	119±3.1	13±1.2	5±1.3	7±1.1
Wahat	*Peganum harmala*	131±2.9	8±1.1	8±1.1	4±0.9
Wahat	*Zilla spinosa*	193±3.1	11±3.1	6±0.0	9±1.3
Wahat	*Zygophyllum album*	83±1.1	14±2.1	9±1.0	7±1.1
Wehait	*Alhagi maurorum*	93±1.3	16±3.0	10±1.6	8.0±1.0
Wehait	*Peganum harmala*	113±1.9	12±1.6	9±1.9	6.0±0.9
Wehait	*Zilla spinosa*	135±3.1	7±1.2	6±1.1	9±0.9
Wehait	*Zygophyllum album*	123±2.1	11±2.6	8±1.1	4±0.1

Table 3. Heavy metal (ug g^{-1}) contents in the root of plants collected from different localities in Saudi Arabia (n = 4, ± standard deviation)

Locality	Plants	Metals (ug g^{-1})			
		Al	Cu	Mn	Zn
Ashafa	*Alhagi maurorum*	45±3.1	7±2.1	6±2.1	14±1.8
Ashafa	*Peganum harmala*	95±2.1	2±0.6	8±0.9	20±0.1
Ashafa	*Zilla spinosa*	60±1.9	7±0.1	2±0.1	23±2.0
Ashafa	*Zygophyllum album*	65±1.1	6±1.1	9±1.1	16±1.2
Toroba	*Alhagi maurorum*	73±3.0	10±2.1	10±1.9	11±1.1
Toroba	*Peganum harmala*	81±2.3	8±1.7	7±0.9	8±1.1
Toroba	*Zilla spinosa*	72±3.0	4±1.9	9±1.1	13±1.0
Toroba	*Zygophyllum album*	66±2.1	9±2.0	4±0.9	13±1.0

Table 3. (Cont.)

Locality	Plants	Metals (ug g^{-1})			
		Al	Cu	Mn	Zn
Wahat	*Alhagi maurorum*	59±1.8	5±1.0	8±1.1	8±2.0
Wahat	*Peganum harmala*	81±2.9	9±1.1	7±0.9	10±1.1
Wahat	*Zilla spinosa*	69±3.0	11±0.9	5±0.6	11±1.9
Wahat	*Zygophyllum album*	72±2.1	4±0.3	3±0.3	11±1.9
Wehait	*Alhagi maurorum*	61±1.8	10±1.1	6±0.8	12±1.1
Wehait	*Peganum harmala*	93±3.1	5±0.9	5±1.1	10±0.9
Wehait	*Zilla spinosa*	81±2.6	9±1.1	7±1.0	10±1.2
Wehait	*Zygophyllum album*	75±2.0	8±1.0	3±0.3	7±0.8

concentration of Cu varied in different parts of the plants [12]. The Cu concentrations in the tested plants fell within the range (2–16 ug g^{-1}) as stated earlier [13]. Fungi contain higher concentrations of Cu than higher plants [14-16].

The concentration of Mn in the plants studied here was ranged 4–10 ug g^{-1}, although a wide range of this element 30–500 ug g^{-1} in other plants was reported earlier [13;17;18]. Plant food stuffs have been reported to contain a much higher concentration of Mn (36–113 ug g^{-1}) compared to the results obtained here [19;20, p. 302].

Zinc has an essential role in the metabolism of higher plants [21;22] and is found in the range of 6–47 ug g^{-1} [23;24]. Our results yielded a range of 2–23 ug g^{-1} Zn in the plants tested which is somewhat lower than the normal concentrations reported from other plants [25], although the concentration of Zn has been reported to be as hgih as 300 ug g^{-1} in some plants [26] but concentration of 300–400 ug g^{-1} are toxic to both barley and oats [26;27].

In conclusion, we find the heavy metal concentrations of plants to be lower than reported earlier from some other species.

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المحتوى المعدني للنباتات البرية التي جمعت من منطقة الشفا وتربة والوهط والوهيط في المملكة العربية السعودية

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(سُلِّمَ في ٣ جمادى الآخرة ١٤١٢هـ، وقُبل للنشر في ١ ذو الحجة ١٤١٢هـ).

ملخص البحث. تم جمع العيِّنات النباتية من منطقة الشفا وتربة والوهط والوهيط ثم حُللِّت لمعرفة محتواها من بعض العناصر المعدنية الثقيلة. أوضحت نتائج الدراسة أن المحتوى المعدني للنباتات التي حلِّلت (مجموع خضري، أو مجموع جذري) تختلف في المحتوى المعدني، كما بيَّنت الدراسة أن عنصر الألومنيوم يوجد بتركيز عالٍ يليه عنصر النحاس ثم المنجنيز ثم الخارصين. ولقد تمت مناقشة الاختلافات في المحتوى المعدني للنباتات المدروسة.

تعتبر هذه هي الدراسة الأولى في المملكة العربية السعودية، وجزءًا من الدراسة الواسعة لتحديد المحتوى المعدني للنباتات البرية لملاحظة مدى التلوث بتلك المعادن.