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TRACE METALS CONTENT IN SOME MARINE PLANTS COLLECTED FROM AL-HODEIDAH, RED SEA COAST OF YEMEN

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ABSTRACT

This investigation involves the utilization of Atomic Absorption Spectrophotometer to determine the heavy metal concentrations and to examine the potential hazard to aquatic plants resulting from the continuous exposure to these elements. Plant samples were collected during 2001 along Al-Hodeidah City, Red Sea coast of Yemen. Eight elements namely: V, Cr, Co, Ni, Cu, Zn, Cd and Pb were determined. The mean concentrations of these metals were different from one plant to another. Highest concentrations of V, Cr, Co, Ni, Cu, Zn, Cd and Pb were: 0.55 in *S. lasifolium*, 20.25 in *T. dichotoma*, 11.75 in *S. latifolium,* 13.25 in *T. dichotoma*, 46.50 in *Padina sp,* 29.70 in *S. lasifolium,* 1.72 in *T. dichotoma* and 5.90 µg/g dry weights in *S. latifolium* respectively. Generally, the study reveals that the levels of these metals in plant samples are within the ranges and/or in some cases lower than those reported in the other parts of the world.

1. INTRODUCTION

Tropical marine environment are increasingly threatened by heavy metals pollution. Yet a little is known about the effects of these elements upon marine plants. The most recent study on the effects of these elements on marine plants was conducted by Al-Khafaji (1997). He found that the trace elements had a harmful effect on marine algal growth.

Excessive levels of metals in the marine environment can affect marine biota (fauna & flora) and pose a risk to humans of sea food. Among the most dangerous pollutants are usually present in extremely small concentration in water on the order of 1 ppb (µg/kg). They include elements like mercury (Hg), cadmium (Cd), silver (Ag), nickel (Ni) and lead (Pb) …etc. Marine plants can extract these elements from solutions into their tissues without apparent harm to themselves. Consequently these plants become harmful and poisonous to human-being, of course to human who consume it.

It was found that aquatic plants are useful indicator for pollution monitoring studies (Philips and Segar, 1986). A large number of experimental and field studies have described the capacity of these plants to accumulate these metal from aquatic environment (Abaychi and Al-Obaidy, 1987; El-Sarraf, 1995; Al-Saad, *et al*., 1996).

The distribution of heavy metals in aquatic plant have been reported during the last two decades in many places of the world (Al-Taee, 1999; Al-Saad, *et al*., 1994; Aboul Dahab, *et al*., 1984) . Other workers have used the aquatic plants in their study for accumulation of trace metals (Lytle and Smith, 1995; Lytle, *et al*., 1996). They found that the aquatic plants can accumulate trace elements in their tissues and they might be used as bio-indicator for polluted waters.

Brix, *et al*. (1983) suggested that the concentrations of some trace elements in above and below-ground parts of the sea grass *(Zostera marina)* which can be used as a measure of the bio-available fraction of these metals in ambient and interstitial waters.

The primary purpose of this investigation is to document the existing levels of potentially hazardous trace elements (V, Cr, Co, Ni, Cu, Zn, Cd and Pb) in the marine plant which collected from Al-Hodeidah area. Data of this nature are particularly important in Yemen Coast along the Red Sea. Since the coastal region is presently experienced a phenomenal rate of growth in term of industrial and urban development. Furthermore, the published information on the environmental levels of heavy metals in marine plants are extremely few. For the above mentioned reasons; we analyzed heavy metals concentration from five common marine plants in Al-Hodeidah Red Sea coast of Yemen were analyzed.

STUDY AREA

The Red Sea coast of Yemen is dominated by the Tehama valley which is a flat and arid desert plan (about 65 Km wide), separating the mountains from the sea. Generally, the shoreline consists of a narrow sandy beach, which is bordered by fringing reefs that interrupted at intervals by inlets that result from drowned valley. In these places, sheltered lagoons and bays were formed. Coral reefs are the best developed, especially in the northern and central portions of the human activities. The area was divided into two sections (Fig.1) as following: Section I, is a site to the north of Al-Hodeidah City in Khor-Katheib, to the north of Al-Hodeidah Port. This location is a bay, so the water mass movement is low, receiving large quantities of wastewater from sewage outfalls which is coming from the treatment plant. Section II, is a sit inside Al-Hodeidah fish port, where the sewage waste waters coming from pipeline, which is not treated. Both of them are located on the Red Sea along Al-Hoheidah coast.

2. MATERIALS AND METHODS

The present study was carried out on the coastal area along Al-Hodeidah city during 2001. The plants chosen were four species of algae: *Sargassum latifolium, Sargasum lasifolium, Taonia dicotoma* and *Padina sp.* and the fifth species was mangrove's (*Avicennia marina*). The algal samples were collected from the beach (Section I & II) and the mangrove leaves were also, collected from an area northern to Al-Hodeidah Port.

The plant samples were wrapped in plastic bags, stored in a cool box and frozen upon return to the laboratory. The samples were washed by double distilled water, dried in an oven and grind with agate mortar. One gram dry weight was digested according to the procedure described by Goldberg *et al.* (1983) to destroy all organic matter and release the ionic and organically bound metals. Wet digestion by using acids mixture at low temperature is the most commonly used procedure. To accomplish this (~1g) dry weight of each sample was transferred to 100 ml Teflon bottle with a screw-on cap and 7.5 ml of concentrated perchloric acid ($HClO_4$), and 2.5 ml of concentrated nitric acid (HNO_3) were added. The bottles were sealed tightly and allowed to pre-digestion overnight in a fume-hood. Then 3 ml of de-ionized water was added. The bottles were reheated while it was open on hot plate to reduce the volume to about 3 ml in the fume-hood. The solution was then carefully transferred to 50 ml volumetric flasks and the bottles rinsed with 5 ml of de-ionized water 3 times, and the final volumes were made up to 25 ml.

Blank and spiked samples were used in parallel with plant samples. The trace metals were extracted in duplicates from the plants and the concentrations of V, Cr, Co, Ni, Cu, Zn, Cd and Pb were measured using flame Atomic Absorption Spectrophotometer (Perkin Elmer 2800).

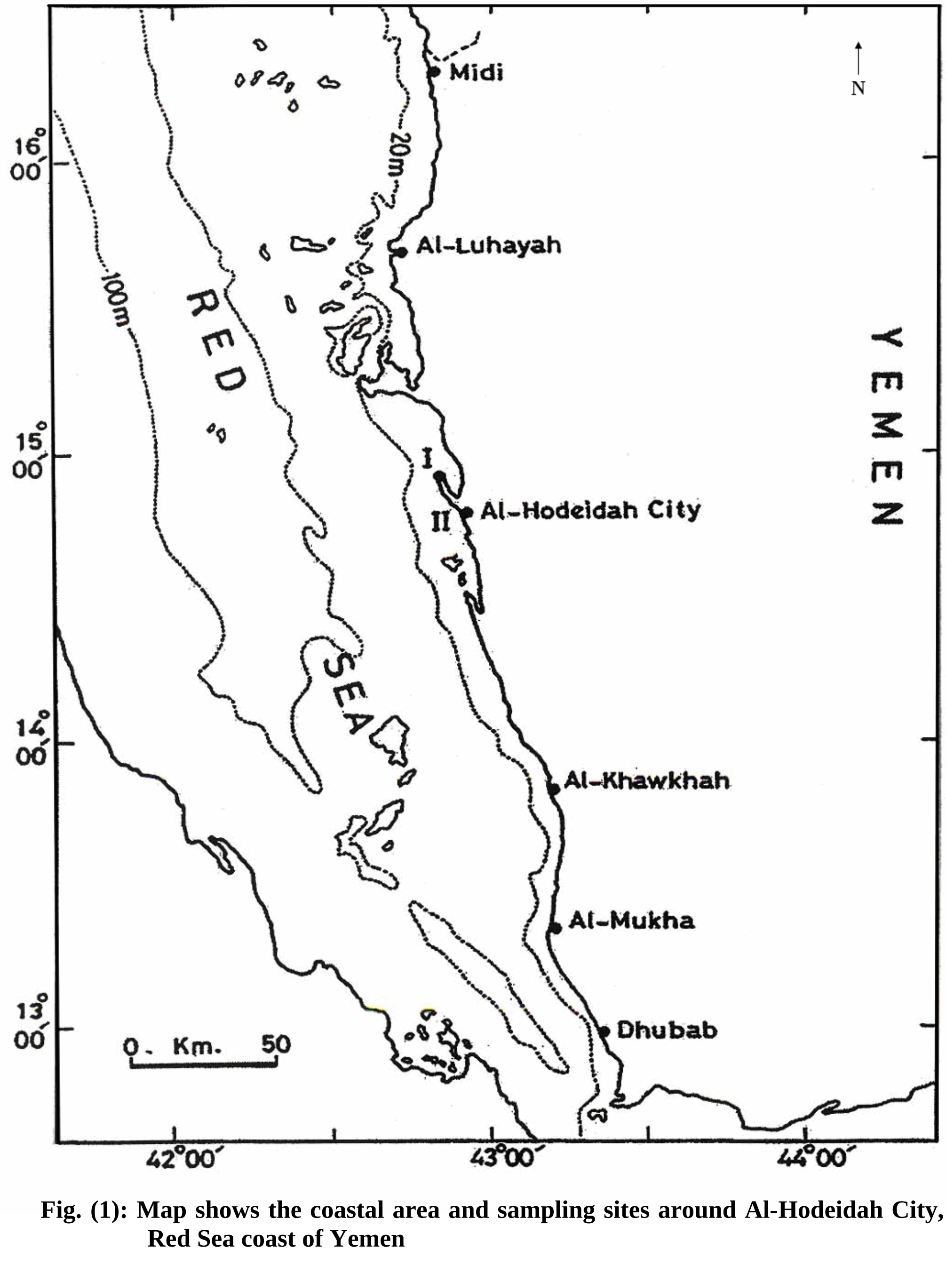

Fig. (1): Map shows the coastal area and sampling sites around Al-Hodeidah City, Red Sea coast of Yemen

Reagent blank was also, included with each set of analysis. Standard addition method was used for the calculation of concentration for metal analyzed. Three replicates of each sample were analyzed and blank values were negligible for all element studies.

3. RESULTS AND DISCUSSION

Unfortunately, there are no available data on the concentrations of trace metals in aquatic plants in the southern area of the Red Sea. In this study, we attempted to provide an overview of the level of heavy metals in the five species of marine plants, collected from shallow water near Al-Hodeidah region. The mean concentrations of the studied trace metals (V, Cr, Co, Ni, Cu, Zn, Cd and Pb) for the plants (*S. latifolium, S. lasifolium, Taonia dichotoma*, *Padina sp*. and *Avicennia marina*) are presented in Table (1) and Fig. (2). It is clear, that there are noticeable variations in the concentration of the trace metals in the present investigation.

Generally, it was found that the Cu exhibited the highest level, while V had the lowest one. The various concentrations of these elements in the marine plants can be described for each species as follows (Table 1 and Fig. 2):

In the tissues of *S. latifolium*, concentrations of the trace metals were ranged between 0.40 and 11.75 µg/g dry wt. for V and Co, respectively.This sp. exhibited . highest level of Co compared with a lower one for *S. lasifolium* and *Padina* sp. The seme trend was also recorded for Pb showing the highest concentration in *S. latifolium*, followed by *T. dichotoma*, while *Padina* sp. had the lowest one (Table 1). The high concentrations of Pb reflect the atmospheric deposition input (air pollution) from motor vehicles using leaded gasoline (Abdelmoneim, 1994 and Al-Saad *et al*., 1994). Much of the atmospheric Pb emanates from its used as anti-knocking additive (Lead tetraethyl) in petrol and its impact on coastal marine environment appears to be very significant (Fowler, 1985). The concentration of Pb which found in the present study was lower than those recorded by Al-Taee (1999), but relatively higher than the data obtained by Al-Saad, *et al*. (1994).

For *S. lasifolium*: The highest concentrations of trace metals was Zn (29.70 µg/g) and the lowest was V (0.55 µg/g) . Generally, Zinc seems to be highly abundant in the Red Sea. Earlier study carried out by Karbe and Schnier (1981) pointed that the Zn levels ranged between 0.03 and 12.30 µg/g dry wt., and the concentration of Zn is higher than Cd and Cu from waters collected at different depths along the Red Sea. In the present study, Zinc had higher concentration than those obtained by Al-Saad *et al*. (1994) for the aquatic plants of Al-Hammar marsh (Iraq) and in agreement with those found by Abaychi and Al-Obaidy (1987) and Al-Taee, (1999). In contrast, concentration of V in this study represent the lowest concentration of trace metals and is lower than those recorded by Al-Saad *et al*. (1994).

For *T. dichotoma*: Cr, Ni and Cd exhibited its highest value (20.25, 13.25 and 1.72 µg/g dry wt.) in the tissues of this sp. when comparing with other studied plants (Table 1). The level of Cr in the present study is in a good agreement with the study recorded by Al-Taee (1999), while Ni showed low values. In contrast, Cr and Ni were relatively higher than those reported by Al-Saad *et al*. (1994). The concentration of Cd in the present study was in agreement with those reported by Abaychi and Al-Obaidy (1987), Abaychi and Al-Saad (1988) and Al-Saad *et al*. (1994).

Table (1): Range, mean and standard deviation of the trace metals concentration in five species of marine plants collected from Al-Hodeidah area, Red Sea coast of Yemen.

Species	Metals (µg/g dry wt.)								Total
	V	Cr	Co	Ni	Cu	Zn	Cd	Pb	
Sargassum latifolium	0.35 -0.44 0.40±0.05	7.50 -8.88 8.13±0.70	11.02-12.94 11.75*±1.04	0.42 -0.65 0.50±0.13	9.85 -11.46 10.50±0.85	5.50 -6.74 6.05±0.63	1.45 -1.72 1.60±0.14	5.39 -6.44 5.90*±0.53	44.33
Sargassum lasifolium	0.46 -0.67 0.55*±0.11	6.03 -6.61 6.25±0.31	6.80 -7.83 7.25±0.53	6.90 -9.69 8.00±1.49	24.30 -31.29 27.50±3.53	26.45 -32.75 29.70*±3.15	1.65 -1.74 1.70±0.05	3.95 -4.73 4.30±0.40	85.25*
Taonia dichotoma	0.33 -0.38 0.35±0.03	18.75 -21.58 20.25*±1.42	8.05 -8.50 8.25±0.23	12.83 -14.01 13.25*±0.66	17.32 -20.27 18.50±1.56	6.90 -7.67 7.20±0.41	1.59 -1.92 1.72*±0.17	4.95 -5.36 5.10±0.22	74.60
Padina sp.	0.11 -0.20 0.15±0.05	13.10 -17.50 15.00±2.26	6.93 -7.81 7.25±0.49	4.99 -6.80 5.75±0.94	43.41 -49.40 46.50*±3.00	2.82 -3.93 3.30±0.57	0.79 -0.94 0.85±0.08	3.12 -3.98 3.60±0.44	82.40
Avicennia marina	0.29 -0.40 0.35±0.06	7.99 -10.15 8.75±1.22	7.86 -8.98 8.25±0.63	10.75 -13.30 12.00±1.28	20.11 -26.15 22.75±3.09	3.50 -3.92 3.63±.22	1.43 -1.80 1.60±0.19	4.01 -4.51 4.20±0.27	61.57

* Maximum value

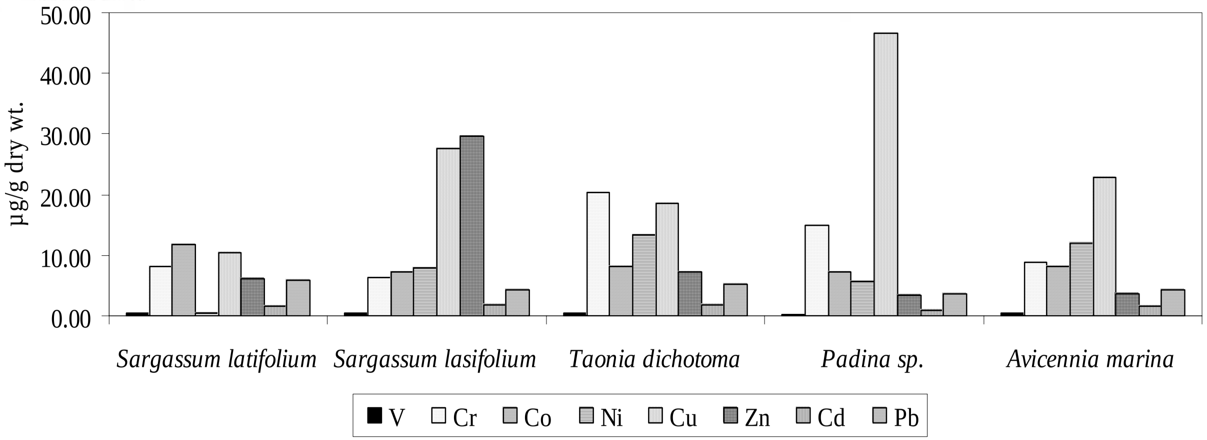

Fig. (2): Mean concentration of trace metals in five species of marine plants collected from Al-Hodeidah Red Sea coast of Yemen.

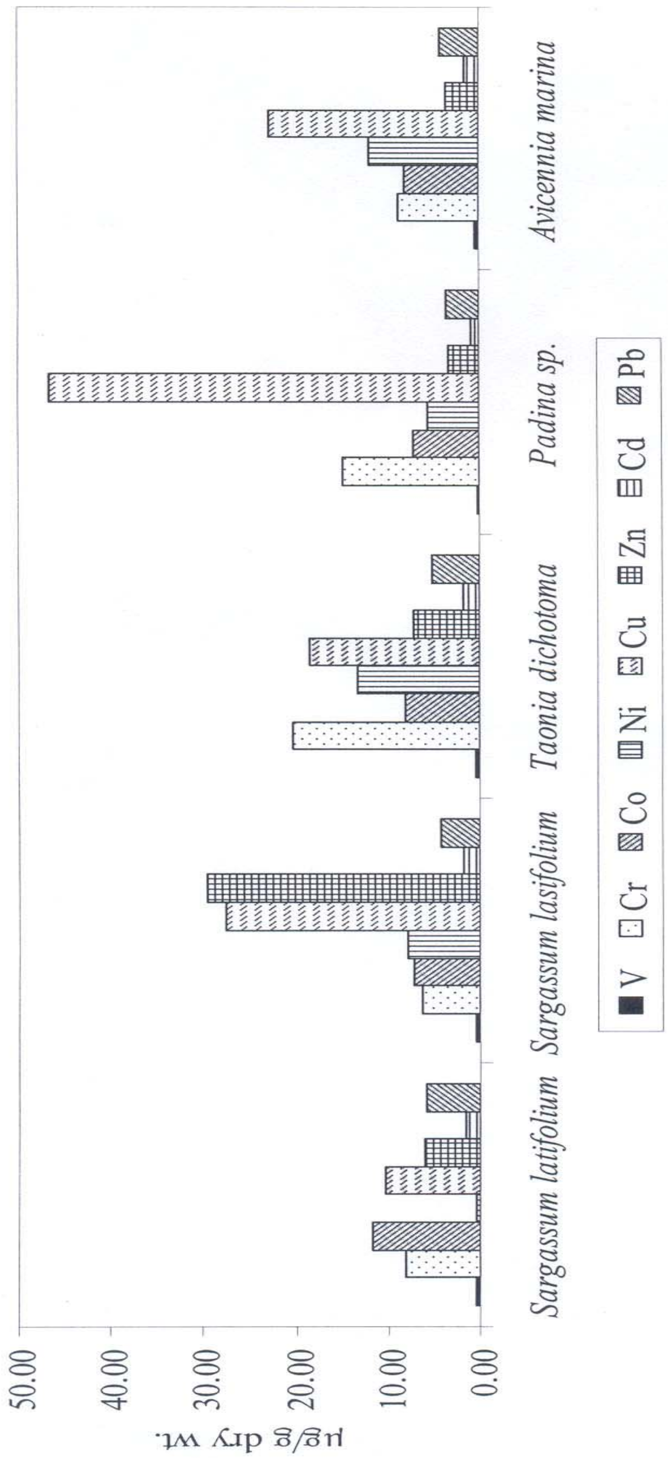

Fig. (2): Mean concentration of trace metals in five species of marine plants collected from Al-Hodeidah Red Sea coast of Yemen.

Among the five studied species, *Padina* sp. had the highest level of Cu (46.50 µg/g dry wt.) and in the same time had the lowest level of V (0.15 µg/g dry wt.). The present level of Cu was higher than those recorded by Al-Taee, 1999 (Table 2). Nevertheless, *Padina* sp. shows the highest concentration of Cu, while *S. latifolium* exhibited the lowest one (Table 1). Martin *et al*. (1977) stated that the used of seawater for cooling in Power Stations has a corrosion effect sometimes lead to local pollution problems particularly for Cu. Another source for this metal is the effluents from the desalination plants or from the antifouling paints.

The mangrove leaves of *A. marina* had the following concentrations: 22.59, 3.67, 4.20, 8.25, 12.00, 8.75, 1.60 and 0.35 µg/g dry weight respectively.

Generally, the marine plants exhibited various concentrations of the studied metals. These variations illustrate the ability of the different species to accumulate certain trace metals (Abaychi and Al-Obaidy, 1987).

Table (2) shows the comparison of the present levels of metals with those recorded for aquatic plants elsewhere. It can be noticed that the levels of the present metals in plant species are within or may be less than the other parts in the world.

4. SUMMARY AND CONCLUSION

The data of the present work indicated that the levels of the studied trace metals (V, Cr, Co, Ni, Cu, Zn, Cd and Pb) in plant samples are within the range of the other parts of the world. *S. lasifolium*, *Padina* sp. and *T. dichotoma* accumulated trace metals higher than those found in the other species. The relatively high levels of metals in aquatic plants could be due to natural discharge and industrial activities. Generally, the descending order of the metal levels in the different species was Cu > Cr > Zn > Co > Ni > Pb > Cd > V. In addition, the bioavailability of plant species to accumulate metals was ordered as follow: *S. lasiflium* > *Padina* sp.> *T. dichotoma* > *A. marina* > *S. latifolim.*

However, it is recommended that a continuous monitoring program for the Red Sea coast of Yemen is needed in order to keep it at least clean and uncontaminated.

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