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MINERAL CONTENT OF SOIL AND WILD PLANTS FROM SAUDI ARABIA

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المحتوي المعدني للتربة والنباتات البرية في المملكة العربية السعودية

عبد الوهاب رجب بن هاشم آل صادق

تم في هذه الدراسة جمع عينات من التربة والنباتات البرية من مواقع مختلفة من مدينة ينبع الصناعية في المملكة العربية السعودية وحللت لدراسة محتواها المعدني . وجد أن عينات التربة تختلف بدرجة كبيرة، كما تحتوي على كميات كبيرة من عنصر الكادميوم والمنجنيز والرصاص ، أما العينات النباتية فتختلف بدرجة بسيطة في محتواها المعدني وأنها أقل من عينات التربة.

تمت مناقشة النتائج المتحصل عليها استنادا على النتائج السابقة في أماكن مختلفة من العالم لمعرفة أثر التلوث البيئي بالعناصر المعدنية الثقيلة على التربة والنباتات البرية.

Key words: Mineral, Soil, Plants, Saudi Arabia.

ABSTRACT

Soil and wild plant samples were collected from different localities from the industrial Yanbu city, Saudi Arabia, and analyzed for their mineral content. Soil samples from the tested localities differed greatly and contained the highest amount of cadmium, cobalt, manganese and lead. Plant sample differed slightly and contained lower amounts of minerals than the soil samples. Heavy metal pollution of soil and plant samples is discussed according to earlier results from different places in the world.

INTRODUCTION

Heavy metal pollution occurs in soil and plants due to industrial wastes and sludge (1, 2, 3, 4). These metals accumulate in urban road-side soils from vehicle emissions and cause damage to the vegetation and microbial flora (5). Industrial Yanbu city is one of the cornerstones of Saudi Arabia's industrial development and diversification program. In late 1977, the Royal Commission completed a 30-year master plant for development of the industrial Yanbu on the Red Sea about 350 kilometres north of Jeddah.

The present investigation aimed to study soil and wild plants pollution heavy metals from different localities from the industrial Yanbu city, Saudi Arabia.

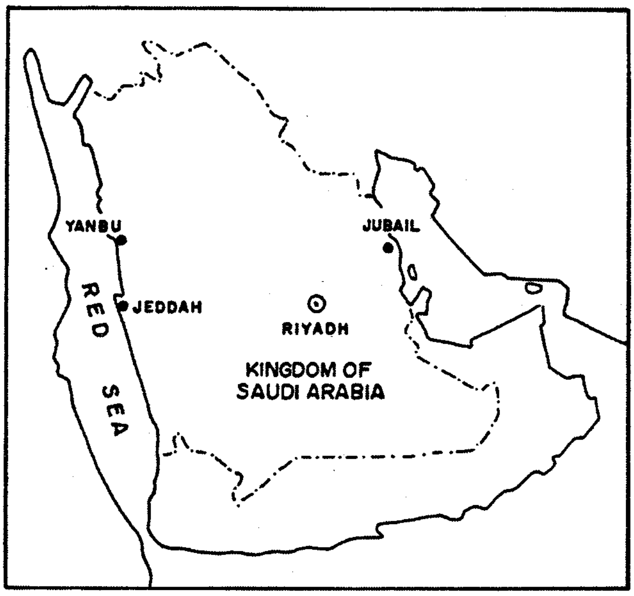

Fig. 1. A map showing the site of the industrial Yanbu City.

MATERIALS AND METHODS

Soil samples from different localities of the industrial Yanbu city (Figs. 1 and 2) were collected according to the method described by Black *et al.* (6) at a depth of 0-12 cm. Five collections of a total weight of 1,000 gm from each locality were mixed and used for heavy metal analysis. The method for heavy metals analysis was similar to that of Hashem (4, 7, 8).

Alhagi maurorum, Blepharis ciliaris, Rhazya stricta and *Zygophyllum coccineum* were collected from the same localities as the soil samples (Fig. 2). The wild plants collected for analysis dominated the vegetation of these localities and are annual herbs. They were identified according to Migahid (9). A detailed analysis of heavy metal content of the plants was described earlier (10).

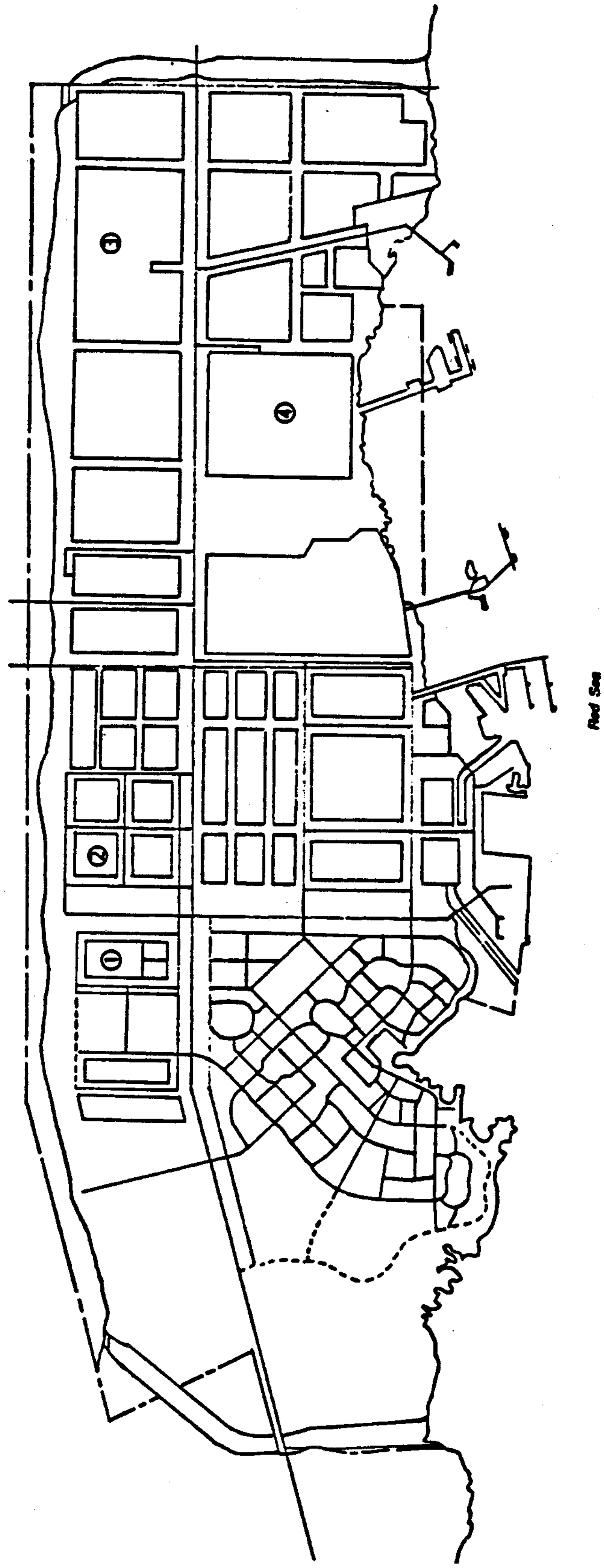

Fig. 2. A map showing the sites of soil and plant samples collection

1. Al-Sawari Area
2. Light Industrial Area
3. Sanitary Landfill
4. Yanbu Petromin Refinery

Table 1
Total metal content (ug/g DW) of the soil samples collected from different localities [n = 5, ± standard deviation, DW = oven dried (up to 90°C) weight basis of samples]

Locality	Total metal content (μg/g DW)			
	Cd	Co	Mn	Pb
Al-Sawari area	13.7 ± 0.8	12 ± 0.1	17 ± 1.1	13 ± 0.6
Light Industrial Park	38 ± 1.6	22 ± 0.9	59 ± 1.5	47 ± 1.1
Sanitary Landfill	95 ± 2.5	55 ± 1.3	90 ± 2.0	68 ± 1.3
Yanbu Petroluem Refinery	83 ± 1.9	39 ± 1.1	78 ± 1.8	85 ± 1.6

RESULTS AND DISCUSSION

The results of total heavy metal content of soil are summarized in Table 1. The soil samples differed greatly. Al-Sawari area soil was lower in metals than the other tested soil because it is the community place for resident people who work in Yanbu city. Sanitary landfill soil was richer in metals followed by Yanbu Petromin Refinery and Light Industrial Park. The Cd concentration in the soil is relatively low and is reported to range from 0.2 to 6 ppm (3). The much higher value (300 ppm) reported by Itoh and Yumura (11) presumably indicates contaminated soil. Cadmium in the test soil ranged 13.7-95 μg/g (DW) (Table 1). The main source of Cd pollution to the environment, however, are metal smelters and toxic effects in man have been observed from regular consumption of plants in excess of 3 ppm Cd. Cobalt concentration in soils is fairly low and ranges from 0.3 to 97 ppm. Other high Co concentrations reported for Australian and Japanese soil are 122-116 ppm, respectively (12). The Co content in the present study ranged from 12 to 55 μg/g (DW) (Table 1). Significant sources of Co pollution are related to non-ferrous metal smelters, whereas coal and other fuel combusion are of considerably less importance. However, roadside soils and street dusts are known to be enriched in Co (13). The mean Mn content in surface soils of different countries ranges from 350 to 2200 ppm. Concentration of Mn in soils analyzed in the present study ranged from 17 to 90 μg/g (DW) (Table 1). Manganese has been considered to be a polluting metal in the soil due to annual dressing with sewage sludge (13). Lead occurrence in top horizons of different soils from various countries show that amounts range from 3 to 180 ppm. The concentration of Pb in the soil studied here ranged from 13-85 ug/g (DW) (Table 1). The fate of anthropogenic Pb in soils has recently received much attention because this metal is hazardous to man and animals from two sources, the food chain and soil dust inhalation. Studies on Pb compounds in contaminated soils have been reviewed by several workers. The accumulation of Pb in surface soils is of great ecological significance because this metal is known to greatly affect biological activity of soils. The increased level of Pb in soil is likely to limit enzymatic activity of microbiota and as a consequence, markedly increase the accumulation of incompletely decomposed soil organic matter, particularly those materials that do not decompose rapidly, such as cellulose (14).

Heavy metal analysis of the plant samples indicated a high manganese concentration compared to Cd, Co and Pb (Table 2). Although Cd is considered to be a non-essential element for plants, it is effectively absorbed by both the root and leaf system. In man and animal nutrition, Cd is a cumulative poison, and therefore, its content in food and feed plants had been widely studied (15, 16). Cadmium concentration in the plants from different places in the world range from 0.07 800 ppm. While the Cd concentrations in the tested plants fell within the range 3.5-17 mg/g (DW). Toxic effects in man or animals have been observed from the regular consumption of plants in excess of 3 ppm Cd (17). In addition, soils along roadside are polluted with Cd from tyres and lubricant oil (1). It is clear from the present study, sanitary landfill and Yanbu Petromin Refinery contained the higher amount of soil and plant Cd (Table 1 and 2). In plants excess Cd may disturb Fe metabolism and cause chlorosis.

The Co content in plants varied considerably, from 8 to 100 ppm (4, 18). A few plant species are less sensitive to excess Co. The swamp black gum (Nyssa sylvatica) which grows in the south-eastern U.S.A. can have a Co content approaching 1000 ppm in the dry matter. The Co concentration in dry matter of the tested plants lies between 3.4-18 mg/g (DW) (Table 2). In nature, although plant species range widely in their content of Co, toxic symptoms are not often observed, when a high Co level is readily available, in polluted soil in particular, it can seriously affect plant growth and metabolic functions.

Loneragam (19) stated that Mn showed a particularly wide variation among plant species grown on the same soil, ranging from an average of 30 ppm (DW) in *Medicago truncculata* to around 500 ppm (DW) in *Lupinus albus*. Manganese content of the wild plants in the present study range from 4 to 33 μg/g (DW) (Table 2). The toxic concentration of Mn to plant is more variable, depending on both plant and soil factors. Generally, most plants are affected by an Mn content around 500 ppm (DW), the accumulation above 1000 ppm (DW) also has been often reported for several more resistant species or genotypes.

Lead is major chemical pollutant of the environment, and its concentration in vegetation in several countries has increased in recent decades owing to man's activities. The great variation of Pb contents of plants is influenced by several environmental factors, such as the presence of geochemical anomalies, pollution, seasonal variation, and genotypic ability to accumulate Pb (3). The Pb content of different plants in the world ranges from 0.08 to 94 (DW) (20). While the Pb content in the tested plants ranged from 9 to 19 μg/g (DW) (Table 2), of great environmental significance is the ability of plants to absorb Pb from two sources, soil and air, even thought Pb is believed to be the metal of least bioavailability and the most highly accumulated metal in root tissues (21). A relatively minor effect on the Pb concentration in plants has been reported for contamination of soil due to agricultural activities and sewage sludge. Elevated Pb contents of vegetables grown in urban and industrial areas present a health risk to man.

Table 2
Total metal content (ug/g DW) of the wild plant collected from different localities
[n = 5, ± standard deviation, DW = oven dried (up to 90°C) weight basis of samples]

Locality	Plant	Total metal content (µg/g DW)			
		Cd	Co	Mn	Pb
Al-Sawari area	*A. mauroum*	6.8 ± 0.1	7.1 ± 0.3	6 ± .06	9 ± 0.1
	B. ciliaris	4.6 ± 0.3	5.5 ± 0.1	4 ± 0.3	13 ± 0.2
	R. stricta	5.7 ± 0.2	6.3 ± 0.2	5 ± 0.5	12 ± 0.1
	Z. coccineum	3.5 ± 0.1	3.4 ± 0.4	9 ± 0.1	10 ± 0.6
Light Industrial Park	*A. mauroum*	12 ± 0.6	11 ± 0.6	15 ± 0.9	16 ± 0.5
	B. ciliaris	11 ± 0.2	15 ± 0.2	11 ± 0.6	19 ± 0.6
	R. stricta	12 ± 0.3	12 ± 0.5	13 ± 0.8	17 ± 0.2
	Z. coccineum	13 ± 0.5	13 ± 0.3	19 ± 0.4	18 ± 0.3
Sanitary Landfill	*A. mauroum*	16 ± 0.3	15 ± 0.3	21 ± 1.1	15 ± 0.9
	B. ciliaris	15 ± 0.3	13 ± 0.5	18 ± 1.3	17 ± 0.8
	R. stricta	17 ± 0.4	14 ± 0.6	23 ± 0.9	16 ± 0.6
	Z. coccineum	14 ± 0.2	13 ± 0.8	30 ± 1.5	19 ± 0.5
Yanbu Petroleum Refinery	*A. mauroum*	19 ± 0.1	18 ± 0.2	23 ± 1.8	18 ± 0.9
	B. ciliaris	27 ± 0.3	17 ± 0.6	16 ± 1.3	19 ± 0.8
	R. stricta	18 ± 0.6	15 ± 0.8	20 ± 1.6	16 ± 0.3
	Z. coccineum	19 ± 0.3	16 ± 0.9	33 ± 1.8	18 ± 1.0

The contamination of soils with toxic environmental contaminants is a pervasive problem of potential human health concern to those working and residing near hazardous waste sites. Soil contamination may directly impact human health through the following human exposure pathway, incidental ingestion of surface soil, direct dermal contact, and the inhalation of contaminated fugitive dusts workers and nearby residents during remedial activities or inclement weather condition. Soil contamination may adversely impact human health by contributing to ground water.

The Jubail and Yanbu industrial cities accommodates several large refining and petrochemical plants, and for this reason heavy metal concentration in the soil reach levels which may be very dangerous for human, animals and plants (22).

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