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Heavy metals content in fadama soils, root, leaf and seed of African locust bean tree (*Parkia biglobosa*) along the river Dilimi in Jos north local government area of Plateau, Nigeria

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ABSTRACT : The aim of the study is to assess the levels of some heavy metal contamination of fadama soils, root, leaf and seed of African locust bean (*Parkia biglobosa*) due to irrigation with sewage –fed river water. Samples of water, soils, *Parkia biglobosa's* root, leaf and seeds were analysed for four heavy metals; Pb, Cd, Mn and Fe using Atomic absorption spectrophotometry (AAS). The results showed the presence of some of the heavy metals in *Parkia biglobosa* roots, leaves, seeds and as well in soil and water which were beyond the limits of World Health Organisation. Iron (Fe) was found to be the most abundant in soil samples possibly as a result of drains from mining activities in the area under study. The soil samples gave 1900 – 29500 (ppm) Fe, the water samples 7- 7.20 (ppm) Fe while the Parkia tree samples gave (Root 686 - 4800 ppm Fe ; 37.32 – 59 ppm Mn ; Seed 134- 3460 ppm Fe ; 0.40- 1.92 ppm Pb; 15- 46.80ppm Mn ; Leaf 198-580ppm Fe ; 30.80-148.80ppm Mn). The values of Fe and Pb recorded for soil, water, root, leaf and seed were higher than the WHO (1993) Standard and FAO/ WHO(2001).Comparing the result of heavy metals in soil,water, root, leaf and seed, it was observed that the concentration of heavy metals were more in the soil and root, confirming a positive correlation between the content of metallic element in the plant and its native soil.

KEY WORDS : Heavy metal, Fadama soil, African locust bean tree (*Parkia biglobosa*)

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Recently, pollution of general environment has increasingly gathered a global interest. In this respect, contamination of agricultural soils with heavy metals has always been considered a critical challenge in scientific community (Faruk *et al.*, 2006). Due to the cumulative behaviour and toxicity, heavy metals have a potential hazardous effect not only on crop plants but also on human health (Das *et al.*, 1997). To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals at higher concentrations can lead to poisoning. Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment (Lenntech, 2004).

Fadama is a Hausa word meaning the seasonally flooded and floodable plains along major Savannah Rivers and/or depression on the adjacent low terraces (Adeyeye, 2005). Fadama utilization has been a major feature of the agricultural, food economic and demographic experience of the Nigerian dry belt. The production of crops throughout the year and are, therefore, of economic benefits to the local communities. Fadama utilization ensures availability of valuable agricultural resources in a zone where rain fed agricultural prospects are poor due to the small and erratic nature of rainfall pattern and endemicity of drought. Of a particular threat to Fadama irrigated crops during dry seasons are industrial effluents from factors and manufacturing facilities which contaminate irrigation channels (Awode *et al.*, 2008).

Food contamination by heavy metals has become a burning issue in recent years because of their potential accumulation in biosystems through contaminated water, soil and air. Therefore, a better understanding of heavy metal sources, their accumulation in the soil and the effect of their presence in water and soil on plant systems seems to be particularly important issues of present day research on risk assessments (Sharma *et al.*, 2004). The main sources of heavy metals to vegetable crops are their growth media (soil, air, nutrient solution) from which these are taken up by the roots and foliage.

Most of our water resources are gradually becoming polluted due to the addition of foreign materials from the surroundings. These include organic matter of plant and animal origin, land surface washing, industrial and sewage effluents (Karnataka State Pollution Control Board, 2002). Rapid urbanization and industrialization with improper environmental planning often lead to discharge of industrial and sewage effluents into rivers. Waste water contains substantial amounts of toxic heavy metal which create problems (Chen *et al.*, 2005 and Singh *et al.*, 2004). Excessive accumulation of heavy metals in Agricultural soils through waste water irrigation, may not only result in soil contamination, but also affect food quality and safety (Muchuweti *et al.*, 2006).

At the beginning of the wet season, fadama are marked by a lush of new vegetation before the upland turns green (Turner, 1977). Fadama soils are used for agriculture and allows the production of crops throughout the year and are, therefore, of economic benefits to the local communities. They are small in size and located in areas regarded as inaccessible and under complicated land ownership arrangements (Alamu, 1996). Fadama lands are under increasing pressure as a result of conflicts arising from competing land uses including haphazard use, intensification of agricultural activities by farmers, pastoralist, fisher folks and other Fadama users (Ardo, 2002).

African locust bean tree, *Parkia biglobosa*, is a perennial leguminous tree that belongs to the Mimosoideae family. It grows in the Savannah region of West Africa up to the southern edge of the Sahel Zone 13^0N (Phatt, 1980). The tree is not normally cultivated but can be seen in the wild in the Savannah region of Nigeria. The seeds are well known for their uses in production of local condiment common known as Dadawa (Hausa) or Iru (Yoruba). It is a good source of timber and is useful in making pestles, mortar, bows, hoe handles etc.

Furthermore, *Parkia biglobosa* is such plant legumes with an outstanding protein quality and its protein quality and amino acid composition has been reported (Nordeide *et al.*, 1996; Ega *et al.*, 1988; Glew *et al.*, 1997; Cook *et al.*, 2000 and Lockett *et al.*, 2000). The present work deals with the quantification and determination of heavy metals, level in Fadama soils and *Parkia biglobosa* tree (Root, leaf and seeds) along the bark of River Dimili in Jos North Local Government Area of Plateau State in Nigeria, having long term uses of untreated sewage water for irrigation as well as indiscriminate release of toxics effluents into the river.

Research Procedure

Analytical reagent (AnalaR) grade chemicals and water were used throughout the study. All glassware and plastic containers used were washed with detergent solution followed by 20 per cent (v/v) concentrated Trixonitrate (IV) acid and then rinsed with water and finally with distilled water (Audu and Lawal, 2005).

For the purpose of determining heavy metal levels in the soil, water, leaves, roots and seeds the species *Parkia biglobosa*, samples were collected (soil, water leaves, seeds and roots) from three sites shown in Tables 1 to 5 and Fig. 1 to 5.

Plant sampling, preparation and analysis :

The mature leaves, roots and dried fruit pods (seed) were randomly sampled (Ayaz *et al.*, 2002 and Asaolu and Asaolu, 2002) from different branches of locust bean trees at farmlands along the bank of River Dilimi in Jos North Local Government Area of Plateau State. The samples were transported to the laboratory in air tight polythene bag where the pods were opened manually. The pulp and seeds were separated with aid of mortar and pestle, sieve to pass through 20 mesh sieve and stored in air tight polythene bags inside a desiccators until they were analyzed. The sample of plant *Parkia biglobosa* was rinsed with distilled water repeatedly. These were dried in an oven at 65^{o}C for about 2 days and ground using cross beater grinding mill. After then, 0.5g of ground plant sample was digested with 5ml of nitric acid and 3 ml of hydrogen peroxide. The digestion temperature was about 160^{o}C.

0.5g of air dried and ground plant part of *Parkia biglobosa* was digested as above. The analysis of lead, cadmium, manganese andiron content in plant was peformed by AAS (Atomic Abs$_3$ orption Spectrophotometry). The guidelines for maximum limit (ML) of heavy metal in *Parkia biglobosa* was adopted from WHO (1993) Standard and FAO/WHO, 2001).

Water sampling, handling and analysis :

Water samples were collected at three different points located within the study area. Samples of water were taken along the river where *Parkia biglobosa* is grown. About 5ml of HNO_3 acid was added to clean 250ml polythene bottles, before adding about 100ml of river water. The HNO_3 acid was for the purpose of acidifying and preserving the water samples. The chemical composition of the water was determined in the laboratory.

Soil sampling, processing and analysis :

Composite surface soil (0-10cm) sample from the *Parkia biglobosa* experimental sites were collected separately and were properly labeled. The soil samples were then air-dried and crushed to pass through a 2mm mesh sieve. Maximum levels (ML) of heavy metals in the soil shall be determined in accordance to (FAO, 1992).
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Research Analysis and Reasoning

The findings of the present study as well as relevant discussion have been presented under following heads :

Level of heavy metals in *Parkia biglobosa* (Leaf) :

Most of the laboratory research on biosorption of heavy metals indicates that no single mechanism, is responsible for metal uptake. In general, two mechanisms are known to occur, *viz.,*'absorption', which refers to binding of materials onto the 'surface' and 'sorption', which implies penetration of metals into the inner matric (Ramraj *et al.*, 2000). Either one of these or both the mechanism migh take place in the transportation of metals into the plant body. Leaf of *Parkia biglobosa* were analyzed for some heavy metal content.The concentration (ppm) of heavy metals in the leaf of *Parkia biglobosa* was highest for Pb.The concentration for Cd, Mn and Fe were within the permissible limit.

Accumlation of these heavy metals in the leaves might be due to the use of sewage fed river water for their cultivation and irrigation. From this results, it is found that the presence of Pb in *Parkia biglobosa* (0.56Ppm)

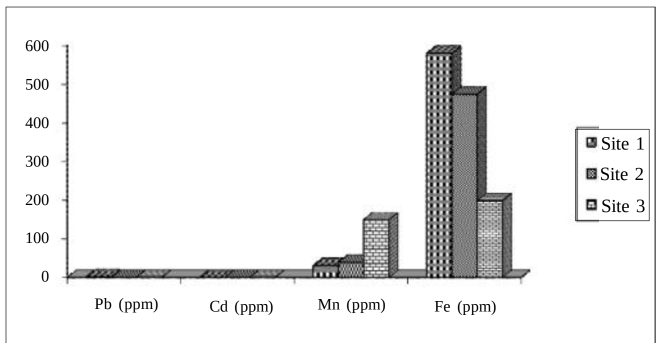

Fig. 1 : Concentration of heavy metals in *Parkia biglobosa* leaves

Table 1 : Leaves

Leaves	Site	Pb(ppm)	Cd(ppm)	Mn(ppm)	Fe(ppm)
	1	1.68	0.00	30.80	580.00
	2	0.00	0.00	39.00	474.00
	3	0.00	0.00	148.80	198.00
	AVG	0.56	0.00	72.87	417.33
	ST-DV	0.97	-	65.88	197.20
	WHO-ML	0.10	0.30	500.00	425.00

is beyond the permissible limit. Lead is a toxic element and high concentrations are unaccepted.

Fe is present in appreciable amount in the leaves. Different vegetable species accumulate different metals, depending on environmental conditions and metal species present. Studies have shown that uptake and accumulation of metals by different plant species depend on several factors, and various researchers have identified several factors (Bingham *et al.*, 1975 and Dowdy *et al.*, 1978).

Total concentration of metal in *Parkia biglobosa* samples :

Levels of heavy metals in the seeds (*Parkia biglobasa*) :

Heavy metals varied with site, the order of toxic heavy metal contamination in seeds is as follows : Fe > Pb > Mn. The heavy metal content of the sample is shown in Table 2.

It is observed that the most abundant metallic element is iron (Fe), whose values ranged from 134 – 3460 (ppm) for the seed sample. However, substantial amount of lead (Pb) e were found in the fruits, which ranged from 0.40-1.92 (ppm). lead is a toxic element and high concentration can result in acute and chronic damage to the nervous system. The seed sample gave values of manganese (Mn) which ranged from 15 – 46.80 (ppm). The average total concentration of manganese (Mn) was lower than the permissible limits (limits are based on WHO guidelines).

Levels of heavy metals in root (*Parkia biglobosa*):

Root samples showed the presence of Fe, Pb and Mn (ppm) considered in the study. Their concentration is

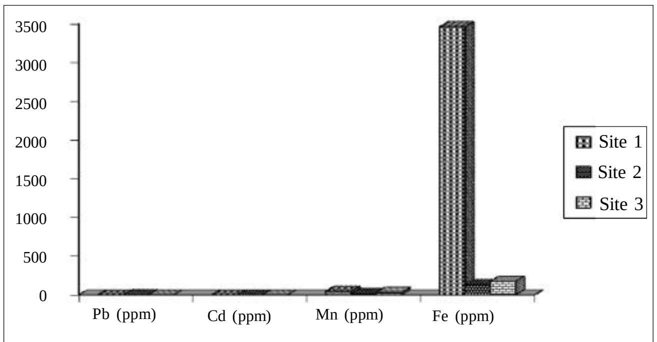

Fig. 2 : Concentration of heavy metals in *Parkia biglobosa* seed

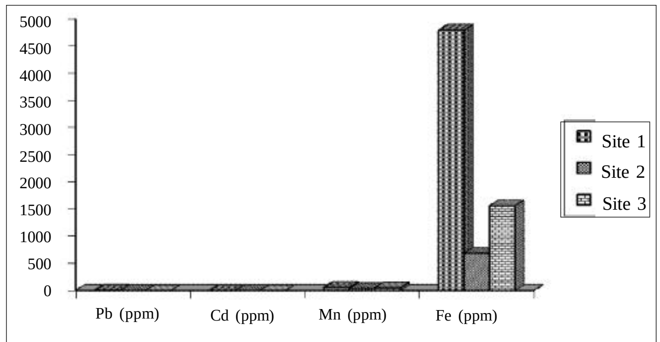

Fig. 3 : Concentration of heavy metals in *Parkia biglobosa* root

Table 2 : Seed

Seed	Site	Pb(ppm)	Cd(ppm)	Mn(ppm)	Fe(ppm)
	1	0.40	0.00	46.80	3460.00
	2	1.92	0.00	15.00	134.00
	3	0.00	0.00	30.20	174.00
	AVG	0.77	0.00	30.67	1256.00
	ST-DV	1.01	-	15.91	1908.82
	WHO-ML	0.10	0.30	500.00	425.00

Table 3 : Root

Root	Site	Pb(ppm)	Cd(ppm)	Mn(ppm)	Fe(ppm)
	1	5.20	0.00	59.00	4800.00
	2	0.00	0.00	37.32	686.00
	3	0.00	0.00	50.00	1560.00
	AVG	1.73	0.00	48.77	2348.67
	ST-DV	3.00	-	10.89	2167.43
	WHO-ML	0.10	0.30	500.00	425.00

represented in Table 3. The order of toxic heavy metal contamination in roots is as follows : Fe > Pb >Mn . From Table 3, iron (Fe) concentration ranged from 686 – 4800 (ppm). However, concentration of Fe and Pb were higher than the permissible limit of WHO. It was found that the concentration of Mn falls within permissible limits.

Levels of heavy metals in the soil and water :

Soil samples of irrigated land used for growing crop plants and vegetables showed the presence of three metals out of the four considered in the study. The highest concentrations were found in Fe and Pb, however, Mn values are found to be significant in the study site. The soil samples gave higher values of Fe than root, seed, leaf and water samples. The order of toxic heavy metal contamination in soil is as shown : Fe > Pb > Mn. This result is obtained from Table 4.

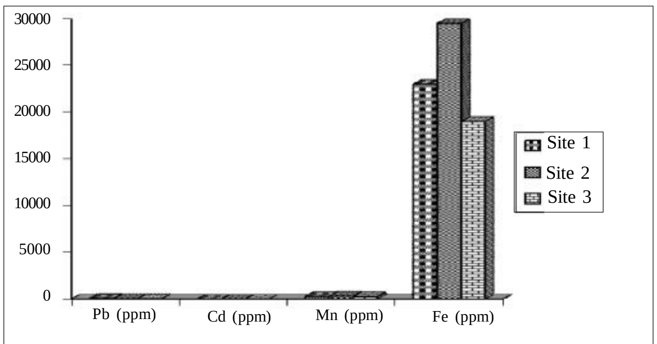

Fig. 4 : Concentration of heavy metals in soil of the study area

Heavy metal content of the water samples is shown in Table 5. From the table, it is observed that highest metallic element in the water samples studied is lead (Pb). The high level of Pb can be attributed to the mines wastes, which often get into the water used for irrigation. The values of Fe in the water samples were lower than those in the soil, root, leaf and seed samples.

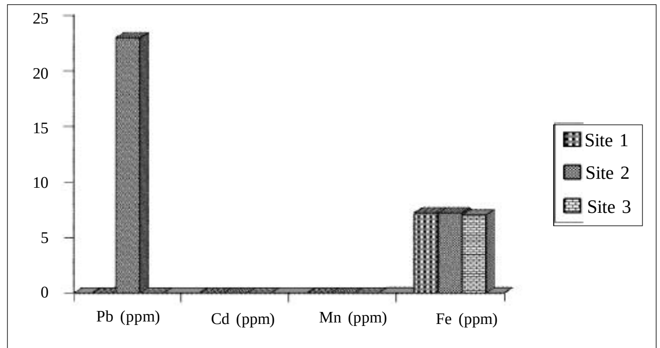

Fig. 5 : Concentration of heavy metals in the river water of the study area

Conclusion :

The soils on the bank of river dilimi is polluted . This is due to the fact that untreated industrial waste discharged into the river contaminate it with heavy metals; Fe, Pb and Mn. Highlights from this study showed the availability of varied levels of some heavy metal pollutant in the soils

Table 4 : Soil

Soil	location	Pb(ppm)	Cd(ppm)	Mn(ppm)	Fe(ppm)
	1	43.50	0.00	274.00	23000.00
	2	15.20	0.00	301.20	29500.00
	3	12.36	0.00	258.00	19000.00
	AVG	23.69	0.00	277.73	23833.33
	ST-DV	17.21	-	21.84	5299.37
	WHO-ML	0.10	0.30	500.00	425.00

Table 5 : Water

Water	Site	Pb(ppm)	Cd(ppm)	Mn(ppm)	Fe(ppm)
	1	0.00	0.00	0.00	7.20
	2	22.92	0.00	0.00	7.20
	3	0.00	0.00	0.00	7.00
	AVG	7.64	0.00	0.00	7.13
	ST-DV	13.23	-	0.00	0.12
	WHO-ML	0.10	0.30	500.00	425.00

and waste water with their resultant availability in *Parkia biglobosa's* roots, leaves and seeds harvested from the same site. Irrigation by wastewater has indirectly engendered accumulationof heavy metals in the agricultural soils as well as in the *Parkia biglobosa* planted in them, such that their concentrations in the soils and *Parkia biglobosa* (except Cd and Mn) exceed the recommended permissible levels by World Health Organization. Hence, soil, water and plant monitoring together with the prevention of metals entering the plant, is a prerequisite in order to prevent potential hazards of irrigation with dilimi river water.

Literature Cited

Adeyeye, E.I. (2005). Trace metals in soils and plants from fadama farms in Ekiti State, Nigeria. *Bull. Chem. Soc. Ethiop,* **19**: 23-34.

Alamu, J.F. (1996). *Marketing of fadama produced tomatoes,* Pepper and Onion./ A case study of Kano and Jigawa State of Nigeria. Ph.D Thesis, Department of Agricultural Economics and Extension ABU Zaria, NIGERIA.

Ardo, H.J. (2002). *Natural resource management and conflict among fadama communities.* A paper presented at the Workshop on Environmental Governance and Consensus Building for Sustainable Natural Resource Management in Nigeria 8th-12th March (2000).

Asaolu, M.F. and Asaolu, S.S. (2002). Proximate and mineral compositions of cooked and uncooked solanum melongend. *Internat. J. Food Sci. & Nutr.,* **53**:103-107.

Audu, A. A. and Lawal, A.O. (2005). Variation in metal contents of plants in vegetable garden sites in Kano metropolis. *J. Appl. Sci. Environ. Mgmt.,* **10**:105-109.

Awode, U.A., Uzairu. A., Balarabe, M.L., Harrisson, G.F.S. and Okunola, O.J. (2008). Assessment of peppers and soils for some heavy metals from irrigated farmlands on the bank of river Challawa, Northern Nigeria. *Pakistan J. Nutr.,* **7**(2): 244-248.

Ayaz, F.A., Hung, H.S., Chuang, L.T., Vanderjat, D.J. and Glew, R.H. (2002). Fatty acid composition of mellar (*Mespilus germanica* L.) fruit at different stages of development. *Italian J. Food Sci.,* **14** : 439-446.

Bingham, F.T., Page, A. I., Hahler, R.J. and Ganje, T. T. (1975). Growth and cadmium accumulation of plants growth on soil treated with cadmium enriched selvage slude. *J. Environ. Qual.,* **4** : 207-210.

Chen, Y. W., Sang, C. and Wang, Z. (2005). Residues and source identification of persistent organic pollutants in farmland soils irrigated by effluents from biological treatment plants. *Environ. Internat.,* **1** : 778-783.

Cook, J.A., Vanderjagt, D.J., Patuszyn, A., Mounkaila, G., Glew, R.S., Millson, M. and Glew, R.H. (2000). Nutrient and chemical composition of 13 wild plant foods of niger. *J. Food Composit. & Anal.,* **13** : 83-92.

Das, P.S., Samantaray and Rout, G.R. (1997). Studies on cadmium toxicity in plants: A review. *Environ. Pollu,* **98**:29-36.

Dowdy, R.H., Larson, W.E., Titrud, J.M. and Latterell, J.J. (1978). Growth and metal uptake of snap beans grown on sewage sludge amended soil.A four year field study. *J. Environ. Qual.,* **7**:252-257.

Ega, R.A.I., Kapu, M. M., Muazu, S. and Olumu, J.M. (1988). Effects of fermentation on distribution of nutrients in the seed of African locus bean (*Parkia clappertoniana*, Keay) and Tamarind (*Tasmarind indica, Linn*) *Nigerian J. Basic & Appl. Sci.,* **2** : 87-94.

FAO/WHO (2001). Codex Alimentarius Commission. Food additives and Contaminants. Joint FAO/WHO Food Standards Programme. ALINO RM, 12A:1-289.

Faruk, O.S. Nazin and Kara, S.M. (2006). Monitoring of cadmium and micronutrients in spices commonly consumed in Turkey. *Res. J. Agric. Biol. Sci*., **2** : 223-226.

Glew, R.H., Vanderjagt, D.J., Lockett, C., Griveth, L.E, Smith, G.C., Pastuszyn, A. and Millson, M. (1997). Amino acid, fatty acid and mineral composition of 24 indigenous plants of Burkina Faso. *J. Food Composit. Analysis* **10** : 205-217.

Karnataka State Pollution Control Board (2002). *Water quality monitoring of lakes in and around Bangalore city,* Bangalore, **2** : 1-8.

Lenntech Water Treatment and Air Purification (2004). *Water treatment,* Publish by Lenntech, Rotterdamseweg, NETHERLANDS.

Lockett, C.T., Calvert, C.C. and Grivetti, L.E. (2000). Energy and Micro-nutrient composition of dietary and medicinal wild plants consumed during drought: Study of Rural Fulani, Northeastern Nigeria. *Internat. J. Food Sci. & Nutr.,* **51** : 195-208.

Muchuweti, M., Birkett, J.W. Chinyanga, E., Zvauya, R., Scrimshaw, M.D. and Lester, J.N (2006). Heavy metal content of vegetables irrigated with mixture of waste water and sewage sludge in Zimbabwe: Implications for human health. Agriculture, *Ecosyst. & Environ.*, **112** : 41-48.

Nordeide, M.B., Hatloy, A., Folling, M., Lied, E and Oshaug, A.

(1996). Nutrient composition and nutritional important of green leaves ands wild food resources in Agricultural district, Koutiala, in South Mali. *Internat. J. Sci. & Nutr.*, **47** : 455-468.

Phatt, G. Cambell-Platt (1980). *Eco Food Nutr.* 0, 123.

Ramraj, Athiya Aftshan, Halappa Gowda, T.P. and Karath, N.G.K. (2000). Sorption of copper (II) and lead (II) microbial cultures during growth. *Indian J. Environ. Health,* **42**: 95 - 99.

Sharma, Rajest Kumar, Agrowal, Madhoolika and Marshal, F.M. (2004). Effects of waste water irrigation on heavy metal accumulation in soil and plants. Paper presented at a National Seminar, Bangalore, University, Bangalore 2004 Abst. No. 7 p. 8.

Singh, K.P., Mohan, D., Sinha, S. and Dalwan, I. R. (2004). Impact assessment of treated/untreated waste water toxicants discharged by sewage treatment plans on health agricultural and Environmental quality in he wastewater disposal area. *Chemosphere,* **55** : 227-255.

Turner, B. (1977). The fadama lands of central northern Nigeria: Their classification, Spatial Variation, Present and Potential Use, Ph.D Thesis, University of London, LONDON, UNITED KINGDOM.

Ward, N.I. (1995). Environmental analytical chemistry. In trace Elements (Eds Field, F.W. and Haines, P.J.) Blackie Academic and Professional, UK, 1995, pp. 320-325.

WHO (1993). Guidelines for drinking water quality, World Health Organization, GENEVA, SWITZERLAND.