ENVIRONMENTAL ASSESSMENT OF COBALT AT WUDIL, KANO STATE NIGERIA

Ahed J Alkhatib
Jordan University of science and Technology, Jordan
Murtala Muhammad
Ishaq Y Habib
Idris M Idris
Bayero University Kano, Nigeria
Auwal Adamu
Ahmadu Bello University Zaria
Sani S Bala
Kano University of science and Technology, Nigeria

Abstract

Introduction: Environmental safety is a large concern at global level. There are numerous bad behaviors that impact environment. Environmental assessment for contamination of heavy metals is an important step to put right policies for environmental protection.

Objectives: The present study was conducted to assess the environmental impacts of Cobalt at Wudil, Kano State Nigeria**.** Cobalt was screened in water, soil, and some vegetables including lettuce, spinach and onion.

Methodology: Study methodology involved taking random samples representing Wudil environment including random samples from soil, water, and vegetables. All samples were prepared and processed to be ready for assaying for cobalt using Atomic absorption spectrometry.

Results: Study findings showed that he mean concentration of cobalt in soil samples at Wudil was 76.22±8.99 µg/g, and in water, it was 0.122±0.08 mg/l. In lettuce, the mean concentration of cobalt was 174.797±14.08 mg/kg, in spinach, 101.63±7.04 mg/kg, and in onion 154.47±18.63mg/kg.

Conclusions: our data demonstrated that cobalt is an environmental pollutant at Wudil, Kano State Nigeria.

Keywords: Wudil, Nigeria, heavy meals, Cobalt, water, soil, vegetables

Introduction

Cobalt is known as a ferromagnetic metal. Its specific gravity is 8.9 at 20°C. Although no pure cobalt is found in nature, many compounds containing cobalt have been identified. It has wide range presence in most rocks, soil, plants, and animals in little quantities. Its atomic number is 27. There is an artificially produced radioactive isotope of cobalt, Cobalt-60, known as an important radioactive tracer and cancer-treatment agent (Stephan, 2000). From a chemical point of view, cobalt is considered a mild reducing agent and by thus oxidation is inhibited by forming oxide film (Edmundo, et al, 2010).

Cobalt is one of the essential elements required to human. It is required to form cobalamin, vitamin B12. Its deficiency causes anemia (Anjali, et al, 2010). Vitamin B12, the coenzyme for methyl transferase, is essential for thymidine synthesis and, ultimately, DNA biosynthesis and the transcription process itself (Yukinori, et al, 2001). Irrespective to the fact that cobalt is an essential element in little quantities, it has been estimated that soluble cobalt salts are toxic and the LD50 is in range between 150 and 500 mg/kg (Donaldson, 2005).

Cobalt has been associated with contact dermatitis and is realized as carcinogenic (Basketter, et al, 2010). It has also been reported to cause beer - drinker's cardiomyopathy after the addition of cobalt to beer to stabilize beer's foam (Donald, 1999).

Several routes of occupational exposure have been proposed to include the respiratory tract (dusts, fumes or mists containing cobalt) and through skin contact (Linnainma, et al,1997). Occupational exposures come from hard-metal production, processing and use, through the production of cobalt powder, in the use of cobalt-containing pigments and driers and during regeneration of spent catalysts (IARC, 1991).

The concentration of cobalt in air is about 1ng/m3 and it reaches up to 10ng/m3 in heavily industrial cities. Drinking water has cobalt in concentration between 0.1-5μg/l. Tobacco also contains cobalt in concentrations <0.01-2.3μg /kg dry weight (IARC, 1991).

Cobalt in dusts, fumes, aerosols or gases is mainly absorbed via the respiratory tract and the digestive tract (IARC, 1991). The rate of cobalt absorption depends on its solubility in biological fluids (Lison, 1996).

Bailey et al (2002) found that the lung retention in two human volunteers after inhalation of cobalt (II,III) oxide particles ranged between 64% and 75% after 90 days for particles with a diameter of 0.8μm and 1.7μm, respectively.

In another study conducted by Lison 1996, it was found that a cobalt concentration of 10μg/kg wet weight in a lung biopsy of a grinder with marked fibrosis exposed to sintered hard metal. It is worth mentioning that the normal cobalt lung concentration is between 3.0-33.0µg/kg wet weights.

It was found that gastrointestinal absorption of orally supplied cobalt chloride varied between 1 and 50% and is influenced by the amount of cobalt given (Midtgård and Binderup, 1994). A blind controlled study (n=23) on gastrointestinal uptake of cobalt chloride and cobalt (II, III) oxide was carried out in men and women by measuring both of urine cobalt and blood cobalt concentrations. It was found that uptake of cobalt chloride was significantly higher than uptake of cobalt (II, III) oxide in both men and women. It was also found that urine cobalt concentrations were significantly higher in females compared to males after ingestion of cobalt chloride (Christensenm, et al, 1993).

There is about 1 to 2 mg of cobalt in the human body and most of it is found in liver (0.01-0.07 mg Co/kg wet weight mainly as vitamin B12), kidney, heart and spleen, whereas low concentrations were found in serum, brain and pancreas (Elinder, et al, 1986). Early investigations showed that intravenous injection of radioactive cobalt chloride in humans was mainly distributed to the liver based on having liver cobalt concentration to be 8 times higher than the mean cobalt concentration of other tissues after three hours of administration (Smith, et al, 1972). Other research studies showed increased cobalt concentrations in breast milk significantly in cobalt exposed mothers (Byczkowski, et al, 1994). Other studies showed that the heart of patients with cardiomyopathy due to consumption of beer containing cobalt salts, revealed more cobalt concentrations of cobalt (about 10 times) higher than in normal cardiac muscle (Seghizzi, et al, 1994).

Cobalt is mainly excreted via urine and feces. Experiments showed that intravenous administration of 60Co was mainly detected in urine (28-56%) and in feces (2-12%). The ratio for cobalt excretion between feces and urine was about 0.2:1. Moreover, the urinary excretion is characterized by a rapid phase of a few days duration (half-times of 9 and 17 hours). It was also shown that about 9-16% of the administered dose had a very long biological half-time (half-time of about 800 days) (Smith, et al, 1972). Kinetic studies of urinary excretion after cobalt dust being inhaled by workers in diamond wheel industry showed a multiphase of graduated pattern (half-time 1st phase 43. h; 2nd phase 10 days, 3rd phase in the order of years in subjects with higher exposure). At the same time, the excretion of cobalt among controls was much rapid during the 1st phase (half-time 20h). According to investigators, this may due to the different body tolerance or to different kinetics created by continuous exposure to cobalt (Mosconi, 1994).

Methodology

The study included 12 soil samples and 8 water samples that were randomly collected in addition to 9 vegetable samples including three lettuces (lectuca sativa), three spinach (spinacia oleracea.l.) and three onions (allium cepa).

The soil samples were air dried, mechanically ground and sieved to obtained <2mm fraction of soil. Soil samples were digested as described by Allen et al (1974) and used for the analysis of cobalt using atomic absorption spectrophotometer. Digestion steps were applied as described by Allen et al (1974). Two grams of soil samples were weighed and wet with one to two drops of water, the sample was digested slowly in a digestion block for one hour after addition $2cm^3$ of sulphuric acid and $4cm^3$ of nitric acid. The digestion was finally diluted and filtered in 50ml volumetric flask and make up to mark with distilled water. The solution was used for cobalt determination.Water samples were collected randomly in plastic containers and digested for elemental analysis using atomic absorption spectrometry.

To a 100cm3 of water sample, l0 $cm^3$of conc. HNO3 were added and boiled slowly on a hot plate to evaporates to about $50cm^3$, after cooling another $5cm^3$ of nitric acid was added and returned the beaker to the hot plate and covered with a glass. Continuing heating was supplied with further addition of nitric acid and completed the digestion when slight colored solution was observed. The beaker wall and watch glass was washed down with distilled water and filtered the solution in to 100ml volumetric flask and diluted to mark with distilled water. The filtrate was used for the analysis of cobalt.

Plant samples were put through a three washing sequence (Reuter et al, 1983), air dried, weighed and placed in a muffle furnace to form an ash which was used for acid digestion (Miller, 1998). Plant digest were used for cobalt analysis by atomic absorption spectrophotometer. Analysis of edible fauna and flora material practically requires ashing of the dry material. Atomic absorbance spectrophotometer offers the advantage that, the ash mostly dissolved in dilute hydrochloric acid can be analyzed directly (Bernard, 1985). Ashing with addition of nitric acid gives very satisfactory results and was adopted (AOAC 1990).

Statistical analysis

Data were analyzed using SPSS version 20. Data were presented as means and standard deviations.

Results

As shown in table 1, the mean concentration of cobalt in soil at Wudil was 76.22±8.99 µg/g, and for water 0.122±0.08 µg/g**.**

Table 1: Cobalt concentration in soil and water at Wudil, Nigeria

	Soil (µg/g)	Water (mg/l)
Cobalt (Mean +SD)	76.22±8.99	0.122±0.08
Range	67.23-85.21	0.06-0.124

As shown in table 2, vegetables at Widul had high amount of cobalt. Lettuce had the highest concentration of cobalt 174.80±14.082 mg/kg, followed by onion in which the mean concentration of cobalt was 154.47±18.63 mg/kg, and spinach 101.63±7.041 mg/kg

Table 2: Cobalt concentration in some vegetables of Wudil (Nigeria)

	Lettuce (mg/kg)	Spinach (mg/kg)	Onion (mg/kg)
Cobalt (Mean +SD)	174.80±14.082	101.63±7.041	154.47±18.63
Range	160.72-188.88	94.59-108.67	135.84-174

Discussion

The purpose of the present study was to explore the environmental exposure to cobalt at Wudil, Nigeria. The data of the present study showed that the mean concentration of cobalt in soil is 76.22±8.99 µg/g.

The average content of cobalt in the soils of the world is about 8 µg/g. An increased amount of cobalt occurs, as well, as a result of industrial pollution. The greatest concentrations have been found in regions with non-ferrous metal smelting industries in the USA (above 154 µg/g) and Canada (above µg/g) (Dojlido and Best, 1993; Dojlido, 1995; Zerbe et al, 1995).

The data of the present study showed that the concentration of cobalt in water at Wudil was 0.122 mg/l. It has been indicated that cobalt occurs in the surface waters in small concentrations, most often of from several to several-score µg . Typical concentrations of cobalt in pure surface waters is 0.05 µg/l. In naturally occurring waters, cobalt occurs in small amounts, its average natural content in river waters is approximately 0.2 µg/l. In ground waters, in reductive environments of temperate zones, cobalt concentrations were, on average, 0.4 µg/l , and in areas of salted over land, approximately 1.2 µg/l (Dojlido and Best, 1993; Dojlido, 1995; Zerbe et al, 1995). Accordingly, water at Wudil area is contaminated by cobalt.

Vegetables from Wudil area reflects high content of cobalt. This reflects the environmental impact of cobalt. We can predict that other plants to have high potential for contamination with cobalt.

Conclusion

The environment of Wudil area at Nigeria is contaminated with cobalt. The present study makes an environmental assessment for environment through water, soil, and vegetables. All measurements were higher than expected ranges.

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