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Short Communication

Heavy metals content in the stem bark of *Detarium microcarpum* determined by atomic absorption spectrophotometer

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Detarium microcarpum **is a member of the Caesalpinaceae sub-family and Leguminosae family of the flowering plants. Beneficial effects of natural products in healthcare delivery in Africa cannot be over emphasized. One of the main concerns with these plant products is the level of heavy metals. The heavy metal analysis was carried out on the stem bark of *D. microcarpum* using an atomic absorption spectrophotometer (AAS). The heavy metals screened for include: lead, chromium, manganese, zinc and iron. The levels of manganese, zinc and iron were 13.91, 4.89 and 21.89 mg/L respectively. These heavy metals were found to be present in the stem bark of *D. microcarpum* at concentration levels higher than tolerable upper intake limits. There is therefore some health implication when ingested. Lead and chromium were not detected in the study.**

Key words: *Detarium microcarpum,* metal, contaminants.

INTRODUCTION

About three-quarter of the World's population relies on plants and theirs extracts for health care (Gabhe et al., 2006). Approximately 70% of Africa's population relies on traditional herbal remedies to meet their primary health care (Addae-Mensah, 1992; Cunningham, 1993). *Detarium microcarpum* is a member of the Caesalpinaceae sub-family and Leguminosae family of the flowering plants. Afieroho reported that the antimicrobial principles in the seed coat of *D. microcarpum* are steroidal saponins and flavonoids with the possibility of synergistic action (Ebi and Afieroho, 2011). However, the hexane and methanolic extracts of *D. microcarpum* did not show any significant activity against strains of *Mycobacterium bovis* (BCG) (Mann et al., 2009). Kouyate (2006) documented the ethanolic extract of the bark to show antimicrobial action against *Pseudomonas aeruginosa*, *Citrobacter freundii*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Streptococcus pyogenes* and *Listeria monocytogenes*. The extract also showed moderate antitumor activity against breast cancer cells (Kouyate, 2006). The methanolic extract of *D. microcarpum* contains flavanes which show strong inhibitory effects on HIV-1 or HIV-2 infection and the bark extract exerts significant molluscicidal activity against *Lymnaea natalensis* (Kouyate, 2006).

One of the main concerns with these plant products is the level of contaminants such as heavy metals. In general, heavy metals are systemic toxins with neurotoxic, nephrotoxic, fetotoxic and teratogenic effects (Rogers et al., 1999). For instance, lead toxicity has been implicated in learning disruptions, overt clinical encephalopathy, atrophy and interstitial nephritis, hypospermia, testicular atrophy, hypertension and biochemical enzyme changes at blood concentrations of 40 to 120 ug/dl (Adepoju-Bello and Alabi, 2005; Adepoju-Bello et al., 2009; Fraga and Oteiza, 2002; Momodu and Anyakora, 2010). Hexavalent chromium compounds have been reported as carcinogens with the kidney as target

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Table 1. Heavy metals content in the stem bark of *Detarium microcarpum*.

Heavy metal	Amount (mg/kg)
Iron	218.9
Manganese	139
Zinc	48.9
Lead	ND
Chromium	ND

ND, Not detected.

organ (Alok and Shikha, 2011), while evidence showed Nickel to permeate human placenta membrane by lipid peroxidation, causing teratogenesis, embryotoxicity, and nephrotoxicity, affecting glycoprotein metabolism (ASTDR, 1997). Iron overload has been implicated in cancer, diabetes, thalassemia, liver and heart diseases (Fraga and Oteiza, 2002). Cadmium and Zinc can lead to acute gastrointestinal and respiratory damages and acute heart, brain and kidney damages.

Chronic exposure to excessive Manganese levels can lead to a variety of psychiatric and motor disturbances, termed manganism. Roth (2006) posits that in initial stages of manganism, neurological symptoms consist of reduced response speed, irritability, mood changes, and compulsive behaviors. With protracted exposure, symptoms are more prominent and resemble those of idiopathic Parkinson's disease. Historically, agriculture was the first major human influence on the soil (Scraag, 2006). Heavy metals are a known contaminant or adulterant of many medicinal products (Bogusz et al., 2002; Obi et al., 2006; Haider et al., 2004) with accompanying clinical manifestations reported (Steenkamp, 2002).

Excessive uptake of metals by plants may produce toxicity in human nutrition, and cause acute and chronic diseases. It was reported that some herbal remedies contained alarming levels of iron, nickel, cadmium, copper, lead, selenium and zinc, which may cause adverse effects when taken as recommended by traditional medicine practitioners (Obi et al., 2006). In line with safety, about 20% of Ayurvedic treatments tested were reported to contain toxic levels of heavy metals (lead, mercury and arsenic) (Valiathan, 2006; Saper et al., 2008). In many parts of Nigeria and some regions in Africa that support the growth of *D. microcarpum*, ingestion of parts of this plant is on the rise because of its usage for the treatment of many disease conditions. The aim of this study is to screen the stem bark of *D. microcarpum* for certain heavy metals using atomic absorption spectrophotometry (AAS) and to extrapolate the health implication of this plant on the population.

MATERIALS AND METHODS

Reagents

All chemicals and reagents were of analytical grade and were obtained from BDH Chemicals Ltd, UK and Buck Scientific Chemicals Ltd. U.S.A. Concentrated Nitric acid was used for the digestion of the samples. Pure samples of the corresponding metal salts were used for the preparation of cadmium, copper, lead, nickel, chromium and aluminum standards respectively (Momodu and Anyakora, 2010).

Digestion of *D. microcarpum* materials

To ensure the metal ions were in solution, the plant stem sample was digested. 1 g of the powdered plant sample was weighed and transferred into a 50 ml conical flask after which added 20 ml of concentrated Nitric acid. The mixture was evaporated in a fume cupboard to half its volume using a hot plate until the brown fumes turned whitish, which indicated completion of the digestion process. The mixture was allowed to cool and then filtered with a Whatman filter paper No 42 (125 mm) into a clean sample bottle. The digested samples were then taken for AAS analysis.

AAS conditions

A four lamp turret Varian 200 flame Atomic Absorption spectrometer was optimized for the determination of lead (Pb), chromium (Cr), iron (Fe), zinc (Zn) and manganese (Mn). The concentrations were measured in parts per million (ppm). The instrument mode was absorbance. The sampling mode of the instrument was manual, set at the prompt measurement mode. The photomultiplier voltage was set at 330 V. Precision of the standard, sample and expansion factor was 1%. A background correction factor was not used in the determination of any of the metals. The reslope was carried out after every 12 samples and the reslope standard was 2.0. The reslope lower limit was 75% and upper limit 125%. The lamp current for all the metals were set between 5-8 mA. The digested samples were then analyzed for each metal in duplicates with the average concentration of the metal present being expressed in mg/L but calculated and expressed in mg/kg.

RESULTS AND DISCUSSION

Five heavy metals were screened for but two of them, lead and chromium, were not detected while manganese, zinc and iron were detected and quantified. The concentrations of the metals detected were: 218.9, 139 and 48.9 mg/kg for iron, manganese and zinc respectively (Table 1). *D. microcarpum* was considered for this screening because of its frequent use for medicinal purposes such as antimicrobial properties (Kouyate, 2006). Iron was found in fairly elevated levels in these plants. Iron toxicity targets organs such as liver and kidneys (Momodu and Anyakora, 2010) which can be a product of chronic ingestion or exposure. Ingestion accounts for most of the toxic effects of iron because iron is absorbed rapidly in the gastrointestinal tract. The corrosive nature of iron seems to further increase its absorption into the systemic circulation. Other implication of this result is a possibility of metal-metal interactions which could prove toxic. For instance, the exact neurotoxic mechanism of manganese is uncertain but there are clues pointing at the interaction of manganese with iron (Verity, 1999; Zheng and Zhao, 2001; Zheng et al., 1999; Zheng, 2001), zinc (Lai et al., 1999), aluminum (Verity, 1999; Lai et al., 1999) and copper (Lai et al., 1999). Researchers have opined that numerous metals in the body cause “synergistic toxicity”. So there is a possibility of these less toxic metals posing some health challenges.

Glutathione and organic acids metabolism play a key role in metal tolerance in plants (Arisi et al., 1997, 2000; Huang et al., 1998; Schäfer et al., 1998; Zhu et al., 1999; Ma et al., 2001). Plants often have a Zn uptake that their systems cannot handle, due to the accumulation of Zn in soils (Wuana and Okieimen, 2011). The possibility of drug interactions with this plant part cannot be overlooked. Clinical and laboratory studies have documented an interaction between fluoroquinolones and multivalent metal cations, such as aluminium, magnesium calcium, iron, and zinc (Michael et al., 1994). Generally, metals have a definite affinity for organic ligands.

The mechanism occurs by the formation of dimer or trimer complexes between the metal ion present in the plant and the organic ligand depending on the valency of the metal ion. This is also the case in drug-metal interactions, consequently affecting the pharmacokinetic profile of the drug molecule in cases of acute or chronic exposure of the plant part.

Conclusion

The atomic absorption spectroscopic analysis of the stem bark of *D. microcarpum* showed the absence of lead and chromium which are considered very toxic heavy metals. But elevated levels of zinc, iron and manganese were found. These metals when ingested by individuals who employ *D. microcarpum* stem bark for ethnomedicinal purposes may experience some health implications following various physiological and biochemical interactions in the body.

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