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Mineral and Toxic Element Constituents of Dutsen Dan Libya (DDL)

[*1]Paul E. D., [1]Okibe F. G., [2]Abdullahi M. S. and [3]Toryila J. E.

[1]Department of Chemistry, Faculty of Science, Ahmadu Bello University, Zaria
[2]National Institute of Leather Science and Technology, Zaria
[3]Department of Physiology, Faculty of Human Medicine, Ahmadu Bello University, Zaria

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ABSTRACT

The mineral and toxic element constituents of Dutsen Dan Libya (DDL), a geological rock material used as a traditional medicine for the treatment of a myriad of ailments was determined by atomic absorption spectrometry (AAS). Parameters analyzed were Calcium (Ca), Sodium (Na) and Magnesium (Mg). Others include Chromium (Cr), Nickel (Ni), Copper (Cu), Zinc (Zn), Cobalt (Co) and Iron (Fe). Results indicate that concentrations of the mineral elements and the toxic metals were within the World Health Organization's Recommended Daily Intake. Ca, Na and Mg levels were 4.20 x 10^{-1} mg g^{-1}, 5.20 x 10^{-2} mg $g^{-1}$and 1.6 x 10^{-1} mg g^{-1} respectively. Others were Cr, 3.92 x 10^{-4} mg g^{-1}, Ni, 9.20 x 10^{-3} mg g^{-1}, Cu, 8.60 x 10^{-3} mg g^{-1}, Zn, 1.00 x 10^{-2} mg g^{-1}, Co, 6.80 x 10^{-3} mg g^{-1} and Fe, 1.40 mg g^{-1}. In view of an average of 20 to 30 grams of the rock sample being ingested twice or thrice daily by the users as a therapeutic solution in water, they are likely to be at risk of accumulation of these toxic elements.

KEY WORDS: Dutsen Dan Libya, Toxic elements, AAS, Medicinal rock

INTRODUCTION

A mineral is a naturally occurring solid chemical substance that is formed through geological processes. It has a characteristic chemical composition, a highly ordered atomic structure, and specific physical properties. By comparison, a rock is an aggregate of minerals and/or mineraloids and does not have a specific chemical composition. Minerals range in composition from pure elements and simple salts to very complex silicates with thousands of known forms. Dutsen Libya is an aggregate of minerals commonly found in North Africa. It is reported to be very common in Libya where the rock derived its name. Preliminary examination at the Department of Geology of Ahmadu Bello University, Zaria, placed Dutsen Dan Libya in the pyroxene group. This rock is used in traditional medicine for the treatment of infections [1]. No record has been found of any study on this material except as verbally reported and prescribed by the traditional healers and as an alternative medicine consumed in the northern parts of Nigeria. A study by Paul et al (2010), of the antimicrobial activity of Dutsen Dan Libya showed that the water extract of this rock demonstrated significant antimicrobial activities against the tested microbes, thus suggesting the reason for its wide application as a therapeutic substance in traditional medicine [1, 2, 3, 4].

A significant observation from the results is the strong activity of the rock extract against *Staphylococcus aureus* (zone of inhibition = 27 mm). This is the microorganism known to play significant role in skin diseases. *Staphylococcus aureus* has demonstrated a resistance to known drugs in recent times [5]. Dutsen Dan Libya also inhibited *Klebsiella pneumoniae*, an encapsulated gram – negative, non motile, pathogenic bacterium that causes severe pneumonitis in humans. Dutsen Dan Libya was also found to inhibit *Corynebacterium ulcerans*, a pathogenic micro organism responsible for zoonotic infections similar to diphtheria [6]. *Candida albicans* a microorganism that causes a fungal infection of the mucus membrane known as thrush, mycosis or candidiasis, was also inhibited by Dutsen Dan Libya. This indicates that the rock can be effective against skin infections, pneumonia, diphtheria and candidiasi, among others.

As a result of these significant findings, we have decided to study the rock further to determine what the elemental constituents are, and how safe it is to the body.

The World Health Organization (WHO) defines traditional medicine as "the health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral-based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being." In some Asian and African countries, up to 80% of the population relies on traditional medicine for their primary health care needs. The World Health Organization also notes, though, that "inappropriate use of traditional medicines or practices can have negative or dangerous effects" and that "further research is needed to

***Corresponding Author:** Paul E. D., Department of Chemistry, Faculty of Science, Ahmadu Bello University, Zaria

ascertain the efficacy and safety" of several of the practices and medicinal materials used by traditional medicine systems [7]

The aim of this study was to determine the level of mineral elements and toxic metals in Dutsen Dan Libya, to ascertain the amount of metals inadvertently consumed along with this drug. The presence of metals in foods, groundwater, soils and other sources can pose significant threat to human health and ecological systems. These heavy metals usually find their way into the body as food, through water, air or absorption through the skin [8].

The direct and frequent ingestion of this rock material is a significant source of the various essential, the not so essential, and the toxic elements into the body. If one makes a practice of consuming Dutsen Dan Libya unchecked, the metals can contribute to the health imbalance of the consumers, both in the immediate and in the long term, as a result of bioaccumulation [9].

MATERIALS AND METHOD

Dutsen Dan Libya was purchased from traditional medicine sellers in Sabon Gari market in Zaria metropolis, Kaduna state, Nigeria. It was then ground into powder in an Agate mortar and pestle. 1.00 g of the sample was digested in a beaker by adding 20ml “Analar” nitric acid solution plus 10ml of 50% hydrochloric acid solution. It was then evaporated to almost dryness on a hot plate and 5ml of 50% hydrochloric acid was added and heated for 15 minutes. The beaker was removed and allowed to cool before transferring quantitatively into a 100ml volumetric flask and made up to the mark with distilled water. The solution was then filtered and analysed, in triplicates, for the various metals using a Shimadzu Atomic Absorption Spectrometer model AA6800 AAS [10].

RESULTS AND DISCUSSION

Calcium and Iron

Presented in Table 1 are the concentrations of calcium, iron, magnesium and sodium in the rock sample tested, along with the World Health Organization’s Recommended Daily Intake (RDI) values for these elements. The mineral calcium is well known for its key role in bone health. It has been said to be very useful in the prevention of osteoporosis. However, too much of calcium has been suspected to be responsible for some kidney and heart problems. The body can handle only about 600 mg of calcium at once; any excess can easily build up in the blood stream and can cause kidney stones when excreted through the kidney in urine. Calcium can also interact with many prescription medications, this negative effect can be minimized by taking in calcium at different times [11, 25]. Mean calcium concentration was found to be 4.2×10^{-1} mg g^{-1}. This is well below the recommended daily intake (RDI) of 1000 mg to 1300 mg per day for an average adult.

Iron is considered an essential element because it is needed to make the oxygen-carrying proteins haemoglobin and myoglobin, found in the red blood cells and in muscles respectively. Iron also makes up part of many other proteins in the human body. Low iron levels over a period of time can lead to iron deficiency anaemia. While it is unlikely that a person can take in too much of iron, hemochromatosis is a genetic disorder that affects the body’s ability to control how much iron is absorbed, thus leading to too much iron in the body [25]. Mean iron concentration of Dutsen Dan Libya was found to be 1.40 mg g^{-1}. This is below the WHO recommended daily intake of 8.00 mg to 27.00 mg per day.

Magnessium and Sodium

It is rare to have a magnesium deficiency, but when this occurs the symptoms include hyperexcitability, muscle weakness and sleepiness. Symptoms of magnesium overdose are even rarer because the body efficiently removes any excess from the system [12]. Magnesium level for the tested rock material was found to be 1.6×10^{-1} mg g^{-1}. This is also well below the WHO RDI.

Sodium is essential to health because it contributes to the electrolyte balance of the body. The recommended adult daily intake is 500 mg. An average American adult consumes between 4,000 mg and 6,000 mg of sodium per day, most of it from food sources. Sodium is completely absorbed after ingestion and infants and young children are more sensitive to high dosages because their kidneys are less matured and control the high concentrations less effectively. An accidental excess dose of 50,000 mg L^{-1} in infant feed has been reported to have resulted in some fatalities. High sodium intake over some years has been linked with high blood pressure. Also, in association with other agents, excess sodium consumption has been implicated in some stomach cancers [13]. Values of sodium concentration in the rock averaged 5.20×10^{-2} mg g^{-1} as given in Table 1.

Table 1: Calcium, Sodium, Magnesium and Iron Compositions of Dutsen Dan Libya and WHO's RDI

Elements	Concentration (mg/g)	Life Stage Group	RDI (mg/d)
Calcium	4.20×10^{-1}	Infants 0 – 12 mo Children 1–8y Others	210 – 270 500 – 800 1000 – 1300
Sodium	5.20×10^{-2}	-	-
Magnesium	1.6×10^{-1}	Infants 0 – 12 mo Children 1–8y Others	0.003 – 0.6 1.2 – 1.5 1.6 – 2.6
Iron	1.40	Infants 0 – 12 mo Children 1–8y Others	0.27 – 11 7 – 10 8 – 27

Chromium and Nickel

The toxic effects of chromium and nickel to both plant and human health are well known. Hexavalent chromium is most toxic because of the chain reactions it can set off in the system as a result of its tendency and propensity to reduce easily from chromium (VI) to chromium (IV) and chromium (III). Depending on the mode of exposure to chromium, several medical conditions may result, including dermatitis, skin ulcers, irritation of the air ways, cough, chest pain, abdominal pain, diarrhoea, heart failure, as well as damaging of the gut, liver and kidneys [14, 15, 16, 17]. The concentration of chromium (Table 2) was 3.92×10^{-4} mg g^{-1}. This would not normally pose a health threat to the users of the medicinal rock in the short term.

Nickel is a dietary requirement for a number of organisms; however it has also been known to have several adverse health conditions for humans, at concentrations above 50 µg/g [18]. According to Das *et al.*, 2008, nickel is a known haematotoxic, immunotoxic, neurotoxic, genotoxic, reproductive toxic, pulmonary toxic, nephrotoxic, hepatotoxic and carcinogenic agent, which acts via the depletion of glutathione and bonding to sulphhydryl groups of proteins. Soils naturally contain between 4 and 8 ppm of nickel, except for mining and other nickel related industrial areas where the concentration can be as high as 9,000 ppm [18]. From Table 2, the average concentration of nickel was determined to be 9.20×10^{-3} mg g^{-1}. This is slightly above the typical natural concentrations of nickel in soil samples (4 ppm to 8 ppm), but below the WHO recommended safe dosage for a day which is 0.2 mg to 1.00 mg per day [19].

Copper, Zinc and Cobalt

Trace amounts of copper is needed by the human body in order to function properly, however, exposure to excess copper can result in nasal and throat irritation, nausea, vomiting, diarrhoea, liver and kidney damage, and possible death [20]. Zinc is also an essential element needed by the body in small amounts. The average daily intake of zinc through food sources is about 5.2 to 16.2 mg in the US. If as large as ten to fifteen times the recommended daily allowance (RDA) of zinc is ingested, even for a short period of time, it can lead to stomach cramps, nausea and vomiting. If ingested for longer periods, anaemia, damage to the pancreas, low birth weight and a decrease in High Density lipoprotein (HDL) cholesterol may occur [21]. Cobalt is another element that is beneficial to man in small quantities as it forms part of vitamin B_{12}. It can be used to treat anaemia in pregnant women because it stimulates production of red blood cells. High concentrations of cobalt above 1 mg can result in vomiting and nausea, asthma, pneumonia, damage to the thyroid, and vision and heart problems [22]. However, cobalt is not a cumulative toxin because it is easily passed out through the urine [23, 24]. Average values for copper, zinc and cobalt as determined for Dutsen Dan Libya are 8.60×10^{-3} mg g^{-1}, 1.00×10^{-2} mg g^{-1} and 6.80×10^{-3} mg g^{-1} respectively.

Table 2: Chromium, Nickel, Copper, Zinc and Cobalt Compositions of Dutsen Dan Libya and WHO's RDI

Metals	Concentrations (mg/g)	Life Stage Group	RDI (mg/d)
Chromium	3.92×10^{-4}	Infants 0 – 12 mo Children 1–8y Others	0.2 – 5.5 11 – 15 21 – 45
Nickel	9.20×10^{-3}	Infants 0 – 12 mo Children 1–8y Others	- 0.2 – 0.3 0.6 – 1.0
Copper	8.60×10^{-3}	Infants 0 – 12 mo Children 1–8y Others	0.2 – 0.22 0.34 – 0.44 0.70 – 1.30
Zinc	1.00×10^{-2}	Infants 0 – 12 mo Children 1–8y Others	2.0 - 3.0 3.0 – 5.0 8.0 – 12.0
Cobalt	6.80×10^{-3}	Infants 0 – 12 mo Children 1–8y Others	- - 0.01 – 0.02

In conclusion, all values obtained were below the WHO Recommended Daily Intake (RDI). However, in view of an average of 20 – 30 grams of Dutsen Dan Libya ingested twice or thrice daily by the users as a therapeutic solution in water, they are likely to be at risk from exposure to these toxic metals. In addition, some of the toxic elements are likely to pose a health risk as a result of bioaccumulation over time.

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