Assessment of Calcium and Magnesium Concentrations in Groundwater as Supplements for Sleep Related Ailments

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ABSTRACT

Calcium and Magnesium are essential to human health. Studies by National Sleep Foundation (NSF), have confirmed these elements as being effective in the treatment of Insomnia. One of the sources of these elements is hard water. In this study, thirty five groundwater samples were collected using EPA standard procedures and analyzed using standard analytical technique. The results showed that 97.14% of the samples are very hard. Values recorded for calcium and magnesium ranged from 3.1±0.26 mg/l to 1524±131.06 mg/l with a mean value of 586.01mg/l and 21±.59 mg/l to 1375±38.5 mg/l with a mean value of 342.83 mg/l, respectively. This indicates that groundwater from the study area could be a good source of calcium and magnesium for inhabitants of the area. The World Health Organization reported that, while the concentrations of calcium and magnesium in drinking-water vary astonishingly from one supply to another, mineral-rich drinking-waters may provide substantial contributions to total intakes of these elements in some populations or population subgroups. It may also be safer compared to most sleeping pills which when taken over long periods of time, can have multiple side effects. Some pills were also reported to have impaired memory and performance on the job and homes.

KEYWORDS: Calcium; Magnesium; Insomnia; Supplements; Hangover; Groundwater

INTRODUCTION

Calcium and magnesium in drinking water have many beneficial effects and are therefore essential to human health although, very high levels can have some negative health effects. For instance, low calcium levels increase the risk for vascular (cerebral) hemorrhage, while high levels promote vascular degeneration (arteriosclerosis). With arthritis, low calcium levels cause inflammatory types of joint disease, while high levels cause degenerative (osteoarthritic) joint damage. Lack of the nutrients calcium and magnesium will cause you to wake up after a few hours and not be able to return to sleep (Balch, 2006).

Both elements are abundant in groundwater, but the role of groundwater as the essential source of these important nutrients is often neglected. In developed countries, calcium (Ca) and magnesium (Mg) have become the "Gold Standard" when discussing nutritional supplements, mineral ratios, paired cell receptors, or many nutrition-related health issues in general. Calcium is now the most promoted nutrient by proponents of conventional, nutritional, as well as alternative medicine - yet at the same time, the assumed need is based purely on the speculation that the body's dietary calcium intake is well below its requirements (MediLexicon, 2009). Chronic calcium deficiency is associated with some forms of hypertension, prostate and colorectal cancer, some types of kidney stones, miscarriage, birth (heart) defects in children. When a mother is deficient in calcium during pregnancy, it can result in menstrual and premenstrual problems, various bone, joint and periodontal diseases, muscle spasms and cramps, sleep disturbances, mental health / depressive disorders, cardiovascular and/or hemorrhagic diseases, and others. Elevated calcium levels are associated with arthritic/joint and vascular degeneration, calcification of soft tissue, hypertension and stroke, an increase in triglycerides, gastrointestinal disturbances, mood and depressive disorders, chronic fatigue, increased alkalinity, and general mineral imbalances.

Calcium and Magnesium are effective in the treatment of Insomnia (an inability to fall asleep or remain asleep) and one of the many sources of calcium and magnesium is hard water. Individuals vary considerably in their needs for and consumption of these elements. Available evidence suggests that, because of food habits, many people in most countries fail to obtain from their diets the recommended intakes of one or both of these nutrients. While the concentrations of calcium and magnesium in drinking-water vary markedly from one supply to another, mineral-rich
drinking-waters may provide substantial contributions to total intakes of these nutrients in some populations or population subgroups (WHO, 2009).

For this study, thirty five groundwater samples were collected and analyzed aimed at evaluating the levels of calcium and magnesium in hard groundwater from parts of northeastern Nigeria (Fig. 1) for use as source of calcium and magnesium supplements in the treatment of insomnia and other related ailments.

The geology of the area is described in detailed in Funtua (1992). It comprises the Precambrian basement, the Late Jurassic to early Cretaceous volcanics, the Bima Group, the Yolde Formation, the Pindiga Formation, and the Neogene to Quaternary basalts.

**Fig. 1: Location map of the study area showing sampling points (inset: map of Nigeria depicting the area studied)**

**GLOBALMAPPER 11**

**MATERIALS AND METHODS**

Groundwater samples were collected directly from wells after purging with “Cole Parmer” environmental sampler for fifteen minutes. Measurement of physico-chemical parameters were made in-situ using Sension 5 meter. These parameters include conductivity, pH, temperature and Total Dissolved Solids (TDS) as shown in Table 1. Analysis of primary measurand was carried out using an inductively coupled plasma optical emission spectrophotometer (ICP-OES).


To check for uncertainty during sampling, samples were duplicated. The samples were collected from the same population and taken through stages of in-situ and laboratory measurements/testing. In the laboratory, Instrument Calibration Standard (ICS) was used to calibrate the analytical equipment used. Analysis of the ICS were later carried out to verify initial and continuing calibration, this is called Instrument Performance Check (IPC). The IPC is used to quantify the instrumental testing repeatability variance and bias. At some stage of the analysis, a clean matrix reference material with an established analyte concentration derived from a source independent of the instrument calibration standard (Laboratory Control Sample) (LCS)) was carried through the entire samples preparation and testing procedure in order to quantify the variance and bias of the chemical preparation and instrument testing stages without matrix interference.

**RESULTS AND DISCUSSION**

The results of in-situ and laboratory measurements are presented in Table 1. The result shows that static water levels in the sampled wells ranged from 0.1 to 26m indicating that water table are deeper in the northwestern part of the study area. Values recorded for pH ranged from 5.6 to 7.9 while conductivity, temperature and TDS ranged from 65.9 µs/cm to 3840µs/cm, 25°C to 35°C and 46.2 to 2260mg/l, respectively. Calcium and magnesium levels in the studied samples ranged from 3.1±0.26mg/l to 1524±131.06mg/l and 21±0.59mg/l to 1375±38.5mg/l, respectively. Highest calcium concentration (Fig. 2) was recorded in samples from Yimirdallang and Walama town while locations with highest magnesium concentrations (Fig. 2) in ground were Dunkur and Yimirdallang (Fig. 1).
Calcium and magnesium are very common elements. Calcium is the fifth most abundant natural element, and magnesium the eighth. Both elements are present in all natural waters. The most common source of calcium and magnesium in groundwater is through the erosion of rocks, such as limestone and dolomite, and minerals, such as calcite and magnesite. Sources of these elements in groundwater from the area calcite and magnesite and are the major contributors to hardness of the water, though hard water is not a health hazard, but it can be a nuisance in homes. One other importance of calcium in groundwater for example is its ability to block the absorption of heavy metals in the body and is thought to increase bone mass and prevent certain types of cancer. Magnesium in drinking water may have a laxative effect, particularly with magnesium sulphate concentrations above 700 mg/L. However, the human body tends to adapt to this laxative effect with time.
Public acceptability of the degree of hardness of water may vary considerably from one community to another, depending on local conditions. Groundwater hardness of the study area varies considerably from one area to another, very hard water is mostly found in the north and southwestern part of the area (Fig. 3). While only few (5%) of the studied samples is soft, slightly hard waters are found around east and southwestern edge of the study area. The taste threshold for the calcium ion is in the range of 100–300 mg/L, depending on the associated anion, and the taste threshold for magnesium is probably lower than that for calcium (WHO, 2011).
Higher magnesium levels (>1000mg/l) in groundwater are found in north and northeastern parts of the study area (Fig. 4) while values of <60mg/l are found around west and southwestern parts of the area. Calcium levels of 750mg/l are dominant in groundwater from most of the studied waters. Only a few samples had calcium levels of less than 100mg/l around southeast and southwestern parts of the study area. Calcium levels of up to 2000mg/l were found in the east and north-central parts of the area studied (Fig. 5).

Risks associated with deficiency and high level of calcium and magnesium in the body is presented in Table 2 while dietary reference Intake (DRI), recommended dietary allowance/intake (RDA) for adults, children, pregnant women and nursing mothers, adequate intake (AI)-tolerable upper intake level (UL) is presented in Table 3.
Table 2: Risks associated with deficiency and high level of calcium and magnesium in the body and sources

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>LOW LEVELS / DEFICIENCY - SYMPTOMS AND/OR RISK FACTORS</th>
<th>HIGH LEVELS / OVERDOSE / TOXICITY / NEGATIVE SIDE EFFECTS - SYMPTOMS AND/OR RISK FACTORS</th>
<th>SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>Insomnia, anxiety, nervousness, depression, fatigue, muscle / joint pains, muscle spasms / cramps, high stomach acid, osteoporosis, seizures, birth defects, miscarriage, high blood pressure, irregular heart beat, cardiovascular disease, hemorrhagic stroke, aneurysms, PMS, dysmenorrhea (painful periods), rickets, higher risk for some cancers.</td>
<td>Arteriosclerosis, cardiovascular disease, arrhythmia, ischemic heart disease and stroke, hypertension, low stomach acid, depression, fatigue, glaucoma, higher risk for several cancers, muscle / joint pains, osteoporosis, osteoarthritis, calcification, dry skin, constipation.</td>
<td>Dairy products, tofu, almonds, brazil nuts, salmon, sardines, broccoli, collard greens, kale, cauliflower, soybeans, seaweed / kelp, hard water, molasses.</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Irregular heartbeat, cardiovascular disease, anxiety, insomnia, nervousness, fatigue, muscle / joint pains, osteoporosis, seizures, high stomach acid, asthma, high blood pressure, PMS, depression, sweating, muscle spasms / cramps, dysmenorrhea, angina, constipation, migraine / headaches.</td>
<td>Cardiovascular disease, arrhythmia, cardiac arrest, coma, muscle spasms, joint / spinal degeneration, bone loss, low stomach acid, low body temperature, low blood pressure, higher risk for several cancers, intestinal / genitourinary bleeding, dry skin, fatigue, depression, dehydration, diarrhea.</td>
<td>Almonds, brazil nuts, soybeans, wheat germ, seeds, wheat bran, millet, legumes, dark green vegetables, fruit, seafood, hard water</td>
</tr>
</tbody>
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Table 3: Dietary Reference Intake (DRI) - Recommended Dietary Allowance/Intake (RDA) for Adults, Children, Pregnancy and Nursing Adequate Intake (AI) Tolerable Upper Intake Level (UL)

<table>
<thead>
<tr>
<th>Calcium: DRI (RDA):</th>
<th>Magnesium: DRI (RDA):</th>
</tr>
</thead>
<tbody>
<tr>
<td>06 months 200mg AI</td>
<td>06 months 30mg AI</td>
</tr>
<tr>
<td>612 months 260mg AI</td>
<td>612 months 75mg AI</td>
</tr>
<tr>
<td>110 years 700mg 1200mg</td>
<td>110 years 80mg 200mg</td>
</tr>
<tr>
<td>1118 years males 1000mg 1300mg</td>
<td>1118 years males 200mg 410mg</td>
</tr>
<tr>
<td>19 + years males 1000mg 1200mg</td>
<td>19 + years males 400mg 420mg</td>
</tr>
<tr>
<td>1118 years females 1000mg 1300mg</td>
<td>1118 years females 200mg 360mg</td>
</tr>
<tr>
<td>1950 years female’s 1000mg 1950 years females’ 200mg 310mg 320mg</td>
<td></td>
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<tr>
<td>50 + years females 1000mg 1200mg</td>
<td>50 + years females 320mg</td>
</tr>
<tr>
<td>pregnant 1000mg 1300mg</td>
<td>pregnant 360mg 400mg</td>
</tr>
<tr>
<td>lactating 1000mg 1300mg</td>
<td>lactating 310mg 360mg</td>
</tr>
</tbody>
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CONCLUSION

From a nutritional perspective, several research studies have shown certain minerals to be effective natural sleep aids that help people fall asleep and stay asleep through the night. This explains why dairy products, which contain both tryptophan and calcium, are one of the top sleep-inducing foods. In magnesium deficiency, chronic insomnia is one of the main, central symptoms. Sleep is usually agitated with frequent nighttime awakenings. On the other hand, high magnesium diet has been found to be associated with deeper, less interrupted sleep. This was proven in a study carried out by Penland, (1988) at the Human Nutrition Research Center in North Dakota. It is important to note that a balanced ratio of calcium and magnesium is vital to overall health, and these two minerals should be taken together for best results. Therefore, Calcium and magnesium levels in groundwater from the study area could be a good source of supplements required by those suffering from such ailments.

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