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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±0.59 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 (osteo-arthritic) 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

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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.

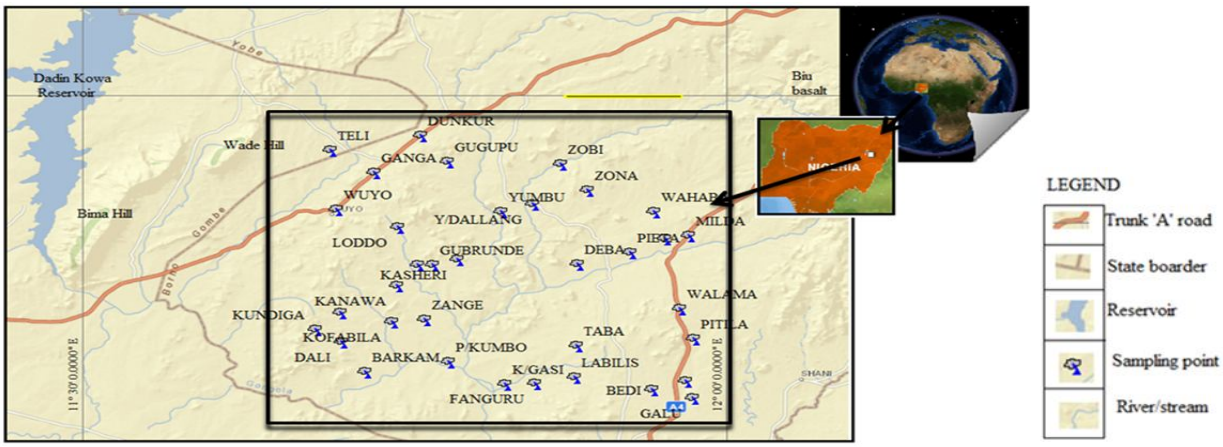

Fig. 1: Location map of the study area showing sampling points (inset: map of Nigeria depicting the area studied) (GlobalMapper 11)

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).

The uncertainty applied to test methods in this study is within the ISO/IEC 17025-1999 Standard General requirements for the Competence of Testing and Calibration (ISO/IEC, 1999). It is based on the general rules outlined in the Guide to Expression of Uncertainty in Measurement (GUM). Components that contribute to analytical measurement uncertainty include sampling, handling, transport, storage, preparation and testing (ISO/IEC 17025-1999) (GUM, 1993).

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.

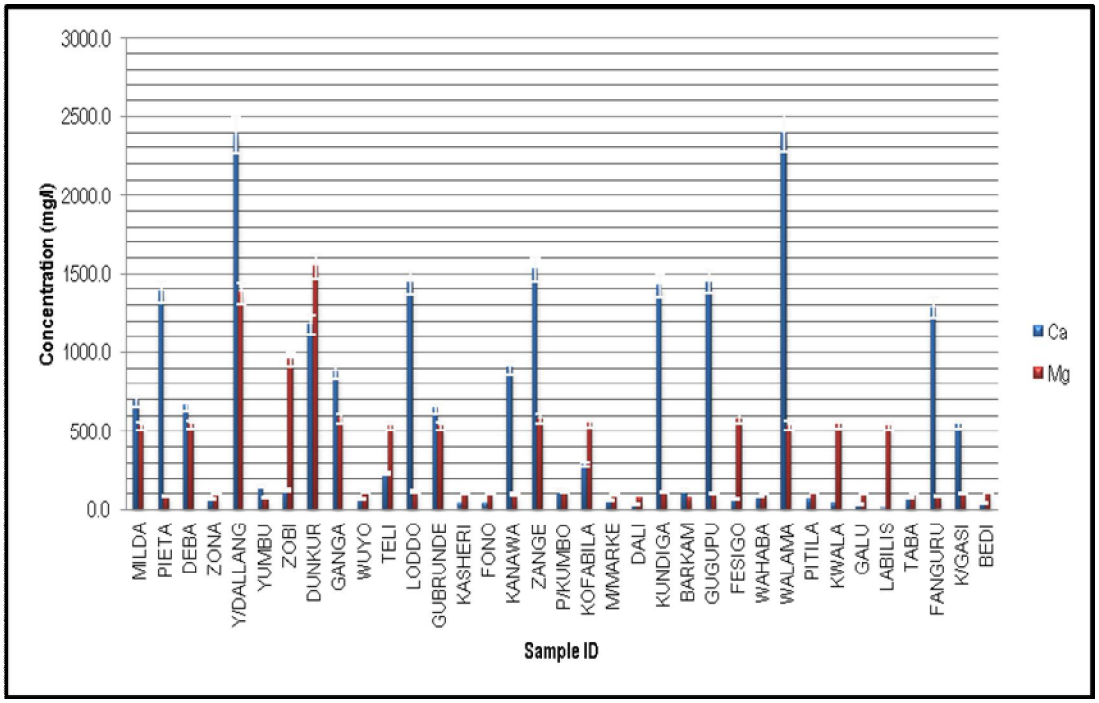

Fig. 2: A bar chart of calcium and magnesium distribution in the studied groundwater samples

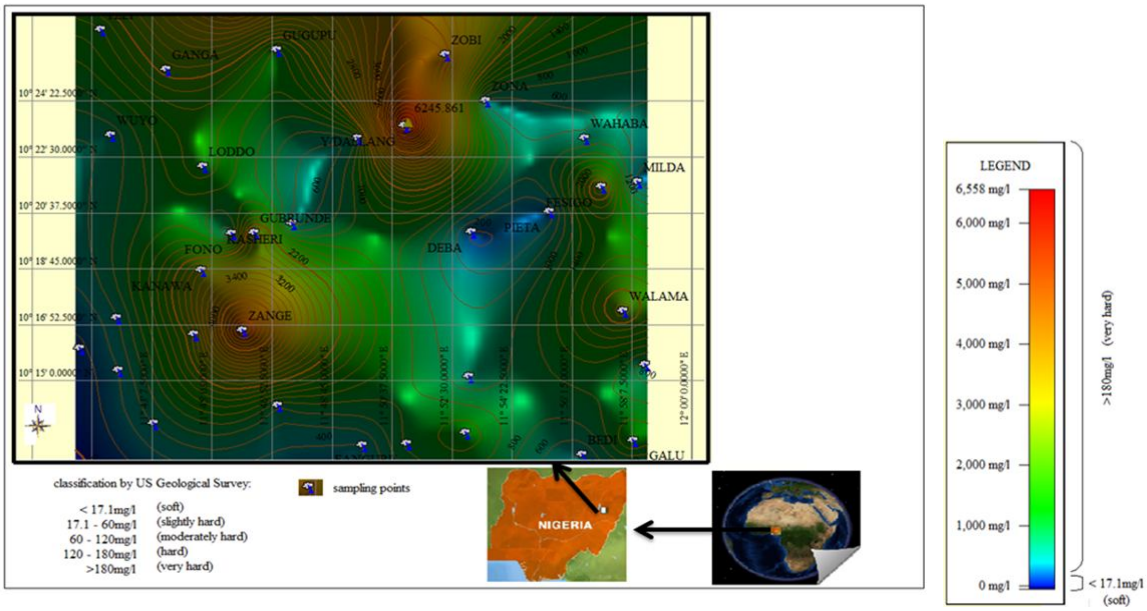

Fig. 3: Groundwater hardness map of the study area

Table 1: Concentrations of calcium and magnesium and some physicochemical parameters of the studied groundwater samples

S/N	LOC. NAME	COORDINATES		IN-SITU MEASURED PHYSICOCHEMICAL PARAMETERS						PRIMARY MEASURANDS	
		LAT	LON	ELE	S.W.L	pH	CON	TEMP	TDS	Ca	Mg
				(m)	(m)		(µs/cm)	(°C)	(mg/l)	(mg/l)	(mg/l)
1	MILDA	1158.154	1021.388	304	1.1	6.8	416	30.2	223	44.2±3.80	32.9±0.92
2	PIETA	1155.318	1020.385	279	4	7.9	852	29.7	464	32±2.75	27.3±0.76
3	DEBA	1153.048	1019.575	263	12.1	6.8	387	31.2	208	24±2.06	21±0.59
4	ZONA	1153.311	1024.21	337	2.1	6.1	85.7	30.9	445.2	50±4.3	80±2.24
5	Y/DALLANG	1150.591	1023.314	286	5.2	7.2	1593	30.8	893	385±33.1	1375±38.5
6	YUMBU	1149.309	1023.062	273	0.7	7.2	312	30.7	166.7	150±12.9	73.2±2.05
7	ZOBI	1152.151	1025.548	288	0.3	7.7	123.1	35	65.1	124.6±10.72	954.3±26.72
18	DUNKUR	1145.446	1027.382	355	8.3	6.7	104.2	30	55.3	1179±101.4	340±9.50
19	GANGA	1143.337	1025.242	323	10	6.4	401	30.6	216	377.1±32.4	283.1±7.91
10	WUYO	1141.491	1023.126	304	26	7.1	596	31	323	70.9±6.1	113.±3.19
11	TELI	1141.307	1026.449	299	10	6.4	370	29.7	198.5	234.6±20.18	232.±6.503
12	LODDO	1144.417	1022.103	342	1.3	6.3	87.6	29.5	46.2	440±37.84	116±3.25
13	GUBRUNDE	1146.188	1019.561	301	3	6.4	474	31.1	255	241.9±20.80	533.1±14.93
14	KASHERI	1147.282	1020.142	303	8.3	7.1	3840	31	2260	35.8±3.08	98.9±2.77
15	FONO	1145.354	1019.544	315	1.5	7.1	236	32.2	125.6	36.1±3.11	105±2.94
16	KANAWA	1144.38	1018.404	293	0.1	6.6	133	30	70.4	901±77.49	97.9±2.74
17	ZANGE	1145.561	1016.407	255	8.1	6.1	1022	30.8	559	1524±131.06	378.8±10.61
28	P/KUMBO	1147.027	1014.081	216	4.6	7.2	89.1	25	47	122.5±10.54	115.7±3.24
29	KOFABILA	1144.248	1016.314	261	7	7	269	30	143.8	290.5±25.00	354.5±9.93
20	M/MARKE	1142	1017.058	313	2.5	7.3	407	28.2	219	56.7±4.88	96.8±2.71
21	DALI	1142.035	1015.201	262	9	7.5	454	28	244	32.2±2.77	72.6±2.03
22	KUNDIGA	1140.501	1016.048	346	7	7.4	622	28.4	336	422±36.3	110.3±3.09
23	BARKAM	1143.091	1013.337	271	8.7	7.3	174	29	92	123.5±10.62	72.1±2.02
24	GUGUPU	1147	1026.04	338	2.1	5.6	65.9	30	34.6	343±29.50	99.7±2.80
25	FESIGO	1157.082	1021.282	290	0.7	6.2	106	29.4	56	66.6±5.73	578.4±16.20
26	WAHABA	1156.377	1023.065	316	2	6.5	182	27.6	96.8	85.3±7.34	102.4±2.87
27	WALAMA	1157.495	1017.188	372	11	7	1206	29.1	663	395±33.79	337.4±9.45
28	PITILA	1158.301	1015.316	318	6	7.1	278	29.1	148.5	63±5.42	115.5±3.23
29	KWALA	1158.7	1012.58	266	3	7.4	106.3	31.5	56.1	38.3±3.30	340.6±9.54
30	GALU	1158.278	1011.581	279	4	7.4	106.1	31	57	32±2.75	101.±2.831
31	LABILIS	1152.541	1013.14	284	0.3	6.1	98.3	31	51.9	3.1±0.26	333.1±9.33
32	TABA	1153	1015.078	391	4	6	98.1	31.5	50.7	75±6.45	104.7±2.93
33	FANGURU	1151.048	1012.512	248	8.1	6.8	246	29.9	131.4	282±24.25	86.6±2.42
34	K/GASI	1149.403	1012.485	218	7	6.5	119.4	32.2	63.2	72.5±6.24	45.1±1.26
35	BEDI	1156.31	1012.305	219	6	6.5	118.7	32	63	31.2±2.68	68.3±1.91

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).

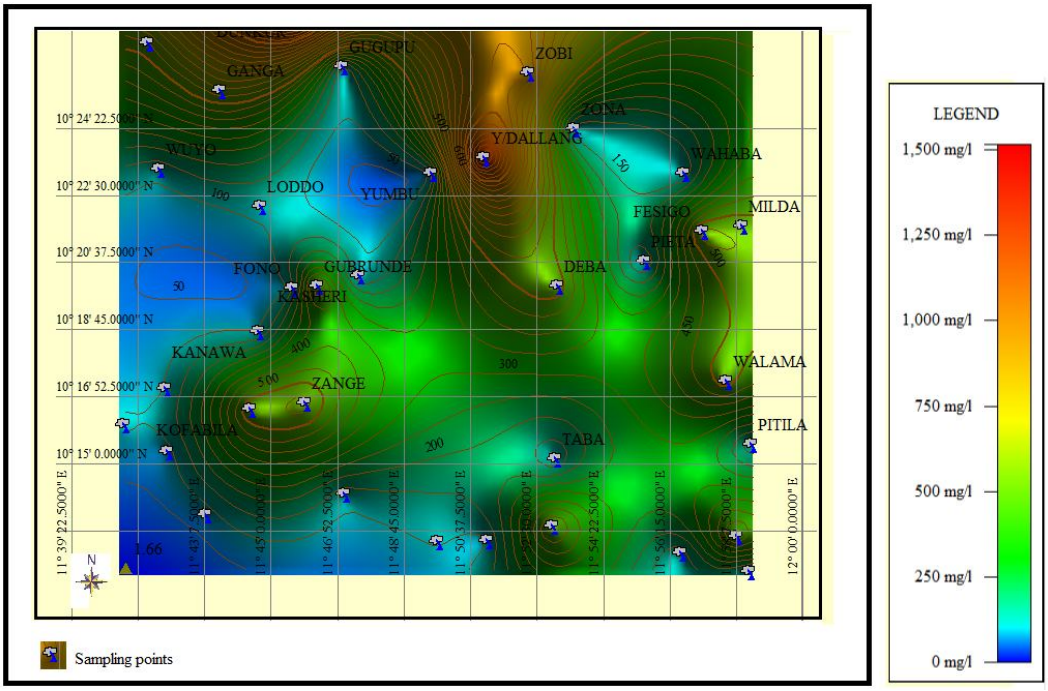

Fig. 4: Magnesium distribution in groundwater of the area

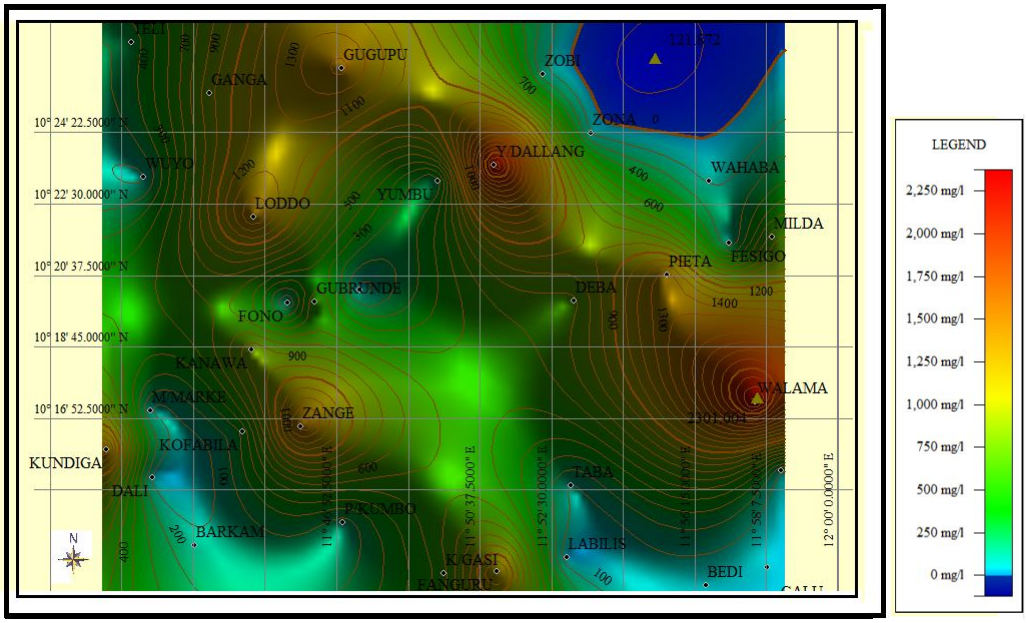

Fig. 5: Calcium distribution in groundwater of the area

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

ELEMENT	LOW LEVELS / DEFICIENCY - SYMPTOMS AND/OR RISK FACTORS	HIGH LEVELS / OVERDOSE / TOXICITY / NEGATIVE SIDE EFFECTS - SYMPTOMS AND/OR RISK FACTORS	SOURCES
Calcium	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.	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.	Dairy products, tofu, almonds, brazil nuts, salmon, sardines, broccoli, collard greens, kale, cauliflower, soybeans, seaweed / kelp, hard water, molasses.
Magnesium	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.	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.	Almonds, brazil nuts, soybeans, wheat germ, seeds, wheat bran, millet, legumes, dark green vegetables, fruit, seafood, hard water

Source: The Clinical Research Resource for Cellular Nutrition & Trace Mineral Analysis. http://www.acu-cell.com/acn2.html

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)

Calcium: DRI (RDA):		Magnesium: DRI (RDA):	
06 months	200mg AI	06 months	30mg AI
612 months	260mg AI	612 months	75mg AI
110 years	700mg 1200mg	110 years	80mg 200mg
1118 years males	1000mg 1300mg	1118 years males	200mg 410mg
19 + years males	1000mg 1200mg	19 + years males	400mg 420mg
1118 years females	1000mg 1300mg	1118 years females	200mg 360mg
1950 years female's	1000mg	1950 years females'	310mg 320mg
50 + years females	1000mg 1200mg	50 + years females	320mg
pregnant	1000mg 1300mg	pregnant	360mg 400mg
lactating	1000mg 1300mg	lactating	310mg 360mg

Source: The Clinical Research Resource for Cellular Nutrition & Trace Mineral Analysis. http://www.acu-cell.com/acn2.html

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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REFERENCES

Arabi, S. A., Funtua, I. I., Alagbe, S. A., Zaborski, P. and Dewu, B. B. M. (2010): Investigation of Groundwater quality for Domestic and Irrigation purposes around Gubrunde and Environs, Northeastern Nigeria. *Journal of American Science*, 6(12): 664 – 672

Funtua, I. I. (1992): Geolgy and Geochemistry of Uranium Mineralization in Mika Northeastern Nigeria. *Unpublished Ph.D Thesis Ahamdu Bello University, Zraia, Nigeria,* 181p

Global Mapper (2007): Blue marble Geographics. Version 13.3. http://www.globalmapper.com

Penland, J. (1988): Effect of trace elements nutrition on sleep patterns in adult women, *Fed. Am. Soc. Exp Biol Jour*, 2:434.

Phyllis, A. B. (2006): Prescription for nutritional healing, 4th edition. Penguin, p869

US Environmental Protection Agency (EPA) (2010): The Analysis of Regulated Contaminant Occurrence Data from Public Water Systems in Support of the Second Six-Year Review of National Primary Drinking Water Regulations. Office of Water (4607M) EPA-815-B-09-006 Revised September 2010. www.epa.gov/safewater

MediLexicon (2009): Nutrition Breakthroughs. "Insomnia: Studies Confirm Calcium and Magnesium Effective." *Medical News Today*. MediLexicon, Intl., 8 Sep. 2009. Web. 6th Jun, 2012. http://www.medicalnewstoday.com/releases/163169.php>

NOVASCOTIA (2008): The Drop on Water: Calcium and Magnesium. Web 11th June, 2012. http://www.gov.ns.ca/nse/water/docs/droponwaterFAQ_CalciumMagnesium.pdf

World Health Organization (WHO) (2009): Calcium and Magnesium in Drinking Water: Public Health Significance, WHO library cataloguing data, NLM classification: QV 276. 193p

World Health Organization (WHO) (2011): Guidelines for drinking water quality, WHO Library Cataloguing-in-Publication Data, NLM Classification. WA 675, Fourth Edition