Sodium Toxicity in Ground Water and its Hazardous Effect on Life – A Study in Tiptur Town and its Surrounding Areas.

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Sodium is the sixth most abundant element on the earth and is widely distributed in soil, plants, water and food. Most of the world has significant deposits of sodium containing minerals, most notably sodium chloride (salt). Sodium and chloride occur in naturally in water as a result of erosion or salt water intrusion. Sodium may reach ground water and surface water supplies as a result of residential, commercial and industrial activity such as road salting. It is generally agreed that sodium is essential to human life. There is no agreement on minimum daily requirement. However it has been estimated that a total in take 120 to 400 mg will meet the daily needs of growing infants and young children and 500mg to those of adults. Sodium salts are not acutely toxic because of efficiency with which mature kidney excrete sodium. However acute effect and deaths have been reported following accidental over doses of sodium chloride. Acute effects may include nausea, Vomiting convulsions, Cerebral and pulmonary Oedema, excessive salt intake seriously aggravates chronic congestive heart failure and ill effects. Due to high level of sodium in drinking water which increase hypertension sensitivity in human beings. Sodium has low acute toxicity in the animals. High doses effects pregnant rats, affects the reproductive rates, hypertension sensitive in rats and same effect was found in related animals. Sodium is major element in igneous rocks, mainly contains 60% feldspars like Na-Ca feldspars. Sodium content in the ground water is a function of weathering of sodium plagioclase from the bed rock following exchange of Ca⁺² for sodium ion on surface of newly formed clay mineral. In addition ground water can contain large amount of sodium from solution of evaporites from salt water intrusion and small amount sea salt in original precipitation. Hence keeping in view that high sodium intake by human beings as well as animals in drinking water, food and accidentally, may cause toxic and hazardous effects on consumers. Since Tiptur people depend on ground water resources for drinking .With this back ground investigation has been made .The study reveals that Na% was ranged between 12.78% to 64 %, which was with in the limits of IS2490 Part –I (BIS) and SAR estimated in all sampling locations were < 10 indicating the good water, as index of sodium hazard according to US ionic regional laboratory. Analysis concludes tiptur ground water was free from sodium toxicity and sodium hazard, can be used for drinking and irrigation.

Key Words: Sodium toxicity, Ground water, SAR, Igneous rocks, Sodium Hazard, feldspars.

INTRODUCTION

The purpose of this paper is to provide information, to people of tiptur town, local drinking water facilities and public health personal on the potential health and esthetic effects resulting from ingestion of sodium containing potable water as well as on the concentration of sodium that are typically found in water sodium is the one of most abundant element on earth and widely distributed in soils, lands, and foods. Most of the world has significant deposits
of sodium containing minerals. Most notably sodium chloride or salt (EPA 2007). Sodium chloride is the most economically and industrially important form of sodium with estimated 14000 direct and indirect uses (Kostick, 1993).

Sodium chloride use can be broken down into eight major categories: chemical (47%), ice control (25%), food processing (5%), General industrial (5%), agriculture (5%), distributors (5%), water treatment (4%), and miscellaneous (4%). Other sodium salts are used in personal care products, foods, nutritional supplements, and medications (MSDS; 2000). Although it is generally agreed that sodium is essential to human life, there is no agreement on the minimum daily requirement; however, it has been estimated that a total daily intake of 120 to 400 mg will be daily needs of growing infants and young children, 500 gm those adults (Luft F C et al. 1979).

The ground water quality often depends on its geological pattern. The feldspars contain the bulk of the sodium in earth crust while clinopyroxenes are te important carriers of sodium in the upper mantle. Sodium is major element in most igneous rocks. Clarke (1924) demonstrated about 60% of the minerals igneous rocks are feldspars either alkali feldspars or Na-Ca feldspars (plagioclase), and bulk of the sodium and potassium spars. Average 2.4% sodium has been reported in pre Cambrian granites world wide. The concentration of sodium in rain and snow is highest near sea and near large cities, since there areas of sodium in put to atmosphere (Dr. Nitesh priya dharshi; 2011).

The sodium content of ground water is a function of weathering sodium plagioclase from bed rock followed by exchange of calcium $\text{Ca}^{+2}$ for sodium on the surface newly formed clays minerals. In addition ground water contains large amount of sodium rock and soil. The common source of sodium levels in the ground water are erosions of salt deposits and sodium bearing rock minerals. Due to brackish water of some aquifers, salt water intrusion into wells in coast areas, infiltration of surface water contained by road salts irrigation sewage effluents and land fills precipitation, leaching through soils high in sodium. (Clarke; 1924).

Salt and sodium chloride are commonly used in water softeners to remove the hardness in the water in homes and businesses. During regeneration of the softeners media, a brine water, sodium and chloride solution is discharged. The maximum allowable sodium in ground water is 120 g/L and for chloride 250 mg/L. Studies have shown that when sodium in drinking water exceeds a certain level it can contribute certain art ailments high blood pressure particularly in susceptible individuals, excessively high levels of chloride in exceeded once of federal drinking water standards while not known to detrimental to health, can make drinking water taste very unpleasant (USEPA; 2008).

Studies of sodium effect revealed that ingestion of sodium is not believed to cause cancer, however some studies shown the risk to cancer by other chemicals in the gastrointestinal tract sodium salt have generally produce in conclusive negative result in vitro or in vivo genotoxicity tests. Very high order of sodium chloride may cause nausea, vomiting, inflammation of the gastrointestinal tract, thirst, muscular switching, convulsions and possibly death. For along term lower level exposures and also primary health effects concern is increased blood pressure (hypertension and age related hypertension). Increased blood pressure has also been clearly demonstrated in several animals species, given high concentration of sodium chloride in their diets. High doses of sodium chloride (About 1,570 g sodium/Kg body weight) have been observed to cause reproductive effects in various strains of pregnant rats (M C Carron; 1098) effects of dams have included decrease in pregnancy rates and eternal body weight gain. (NAS; 1977, Muntzel M., Drueke T; 1992). People of tipur area depends on purely on the ground water resources for their drinking purpose. With this background the study of toxicity of sodium and its effects have been discussed in this paper and also the investigation advises to the consumers by analyzing the quality of ground water about detrimental effects of high sodium content in the ground water of tipur town and its surrounding areas for there diet in drinking water, food and its sod city for irrigation.

Study Area

Karnataka state is situated in the southern peninsular India. Tiptur town is about 75 km from Tumkur district. It covers an area of 785 sq km having 13°16' north latitude 76°29' east longitude and an altitude of 850.30 meter above the sea level. The average temperature ranges 11° in winter and 38° during summer. The average rain fall of Tiptur town is 503 mm. According to geological survey Tiptur comprises more than 80% hinterland soil alluvial with red sandy soil and minor patches of black soil. Rock pattern mainly gneissic rock, limestone, soapstone and as granite strata of tumkur.

MATERIALS AND METHODS

Water samples from 50 sampling locations were collected during pre monsoon season of 2010. The samples were collected in sterilized 1 liter bottles and Total dissolved solids content was noted at the spot by water analyzer kit (global make). The sample were immediately taken to laboratory and analyzed to avoid imp editable changes. Sodium and potassium were analyzed using Flame photometer. Total hardness, calcium, Magnesium, Chloride were analyzed by using standard methods of APHA, 1992.

RESULTS AND DISCUSSIONS
Groundwater plays an important role in both private and public water supplies all over the world. Some areas on the in India have problem of relying on water supply system, that use only surface water and water from the well. The Tiptur town belongs to southern India, Tumkur district, Karnataka. Therefore this paper presents the qualitative analysis of minerals present in the ground water especially sodium chloride (salts) than do surface waters. The paper mainly focuses on the sodium content in the form of salt (NaCl), its toxicity and Hazardous effects on the human life and animals. The water quality data with existence trends and the evaluations was made keeping standards of WHO BIS and ICMR & EPA as model was performed in order to classify the quality of ground water. The information gathered in turn help the people of Tiptur and animals to lead healthy life with out detrimental effects. Table -1 represents high lights sodium, chloride and some dissolved minerals like, Mg+2, Ca+2, K+. The parameters like TH and TDS. Graphs 1-2, show Na+ verses sampling locations and variation of SAR verses samples, as per table -1, respectively.

**Chemical constituent**

**Total dissolved solids**

Total dissolved solids represents minerals present in ground water samples. By definition it is filtered sample after evaporation, contains HCO3, Ca+2, Mg+2, Na+, K+, PO4, SO4, CL-, NO3-, boron and silica etc. In the present study it varied between 213 mg/L to 2139 mg/l in the collected 50 samples under study and are with in WO limits, except few locations.

**Total Hardness**

Hardness often referred as soap consuming property of water. Hardness includes mainly Calcium and Magnesium. In the study area calcium varied between 11 mg/L to 153 mg/L and magnesium between 147 mg/L to 207 mg/L. The total hardness was ranged between 100 mg/L to 1180 mg/L. Calcium and Magnesium may be calculated by TH = (2.497*Ca+2 + 4.118* Mg) where Ca+2 & Mg+2 expressed in mg/L (APHA).

**Sodium and Chloride**

This paper focuses more on sodium content in the study area for its effects. Sodium is an important constituent for determining the quality of water. Sodium bearing mineral
Table 1. Sample locations sowing high values of sodium as per ICMR, DEQ and EPA limits in and around Tipturtown

<table>
<thead>
<tr>
<th>Sample locations</th>
<th>TDS mg/L</th>
<th>TH mg/L</th>
<th>Ca+2 mg/L</th>
<th>Mg+ mg/L</th>
<th>Na+ mg/L</th>
<th>K+ mg/L</th>
<th>Cl- mg/L</th>
<th>Na%</th>
<th>SAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>622</td>
<td>240</td>
<td>39</td>
<td>34.6</td>
<td>150</td>
<td>6</td>
<td>160</td>
<td>58.21</td>
<td>4.21</td>
</tr>
<tr>
<td>S4</td>
<td>780</td>
<td>315</td>
<td>83</td>
<td>26.1</td>
<td>187</td>
<td>10</td>
<td>305</td>
<td>57.1</td>
<td>4.5</td>
</tr>
<tr>
<td>S6</td>
<td>680</td>
<td>205</td>
<td>68</td>
<td>8.54</td>
<td>147</td>
<td>4</td>
<td>270</td>
<td>61.32</td>
<td>4.46</td>
</tr>
<tr>
<td>S7</td>
<td>640</td>
<td>195</td>
<td>57</td>
<td>30.26</td>
<td>144</td>
<td>2</td>
<td>180</td>
<td>61.6</td>
<td>4.45</td>
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<tr>
<td>S8</td>
<td>1387</td>
<td>222</td>
<td>92</td>
<td>1.7</td>
<td>187</td>
<td>10</td>
<td>440</td>
<td>64.03</td>
<td>5.29</td>
</tr>
<tr>
<td>S9</td>
<td>914</td>
<td>100</td>
<td>69</td>
<td>17.4</td>
<td>144</td>
<td>13</td>
<td>187</td>
<td>57.45</td>
<td>4</td>
</tr>
<tr>
<td>S10</td>
<td>994</td>
<td>502</td>
<td>90</td>
<td>67.3</td>
<td>145</td>
<td>20</td>
<td>305</td>
<td>40.4</td>
<td>2.8</td>
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<tr>
<td>S14</td>
<td>1020</td>
<td>270</td>
<td>91</td>
<td>10.3</td>
<td>145</td>
<td>10</td>
<td>240</td>
<td>54.91</td>
<td>3.84</td>
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<tr>
<td>S16</td>
<td>1367</td>
<td>660</td>
<td>108</td>
<td>130.5</td>
<td>150</td>
<td>110</td>
<td>330</td>
<td>41.46</td>
<td>2.54</td>
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<tr>
<td>S22</td>
<td>1341</td>
<td>770</td>
<td>32</td>
<td>167.5</td>
<td>151</td>
<td>11</td>
<td>225</td>
<td>30.81</td>
<td>2.36</td>
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<tr>
<td>S46</td>
<td>1173</td>
<td>1000</td>
<td>32</td>
<td>223.4</td>
<td>140</td>
<td>10</td>
<td>151</td>
<td>24.91</td>
<td>1.92</td>
</tr>
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</table>

WHO, BIS Standards

500mg/L to 1500mg/L
300mg/L to 600mg/L
75-200mg/L
30-100g/L
ICMR&E PA
120mg/L

Graph

Figure 1

Like albite and other members of plagioclase feldspars, nepheline to release the primary soluble sodium products. Most sodium salts are readily soluble in water. The sodium content in water sample were varied 38g/L to 187mg/L. But as per medical researches sodium content in drinking water must be 120 mg/L (USEPA;2008). Especially for human being having sensitive hypertension, must consume with 30mg/L to 60mg/L as threshold dose. In the study area S1, S4, S6, S7, S8, S9, S10, S14, S16, S22 and S46 about 20% sampling locations are exceeding the limit of EPA and UPSPA;2008standards, which may affect consumers. Excess in take of sodium in drinking water may cause nausea, vomiting, In lamination of gastrointestinal tract, Thirst and muscular twitching and long term exposure, primary health concern increased blood pressure (hyper tension) Karr Dullien; 1979. The studies have been made on change of taste and odor. The worlds health organization has established drinking water guideline of 200mg/L on bases of esthetic sense consideration ie (taste). But according to Department of Environmental quality 120mg/L, when sodium chloride is dissolved in distilled water, it is possible to detect the overall impact on taste prior to recognition of the taste as salty (Fregly M J; 1981). But in the sampling location...
under study 80% samples were with the standards of Environmental protection Agency. The major source of chloride in natural water are sedimentary rocks particularly evaporates. Igneous rocks contribute a portion of total chloride. The chloride content was determined by using 0.1N AgNO3 solution. In the present study chloride ion content in all ground water samples were ranged from 52mg/L to 440mg/L. But according to ICMR Standard limits for domestic industrial purposes maximum permissible limit is 600mg/L. But according to DEQ drinking water Environmental protection Department chloride concentration must be 250mg/L.

Potassium

The concentration of potassium in the ground water compared to sodium is very less nearly 1/10th This is because the potassium mineral are resistant to the decomposition by weathering the potassium concentration was determined by Flame photometer. The analysis of potassium in study area in indicates the values were varied between 2mg/L(S7)to 118mg/L (S16, S26, S32). The investigation implies that 80% of samples were free from sodium toxicity and quality of water is good for human consumption. Out of 50 samples 20% were exceeding EPA and DEQ limits(120mg/L), requires some dietary advice for consumers to avoid detrimental effects. Water quality problems in irrigation water include salinity and toxicity .The total solid content gives the salinity hazard. Sodium hazard is expressed by calculation of SAR and its concentration is expressed in terms of Na%.

CONCLUSION

The present study reveals that the parameters under consideration like TH, TDS, K⁺, Cl⁻ were well with in WHO &ICMR limits. It also reveals sodium concentration in 80% of sampling locations were concurrence with EPA and DEQ (120mg/L). But in 20% of sampling locations it exceeds the limits ,for such locations it is advised to water supply department not to add salts for drinking water for softening hard water. It is also advised to ground water consumers for diet and also change the water source for drinking, to avoid for those sensitive to hypertension, old aged people to keep good health. To avoid leaching, infiltrations and percolations by domestic waste, sewages, industrial effluents to ground water and must be maintained by Municipals. As per salinity Hazard (SAR) and calculation of Na% it was concluded that water in tiptur town was suitable for irrigation. Hence tiptur and its surrounding area was free from sodium toxicity and its hazards (80%) and chronic use of 20% samples by consumers may cause detrimental effects on human and animal life.

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