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## A STUDY ON EFFECTS OF HARD WATER ON HUMAN HEALTH

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### KEYWORDS

Water, hard water, human health, save water, re-cycle water.

### ABSTRACT

Water, a universal solvent is transparent, colourless, odourless and tasteless chemical substance. Water is essential for hydration hence needed for survival of life. According to the Bureau of Indian Standard, water having the value of total dissolved solid greater than 500 ppm may be moderately hard or hard and this water can affect the human health on continuous consumption for a long time. Quality and quantitative frameworks of physicochemical and biological components of drinking water are required to regularly pay attention the quality of water from different sources of supply. This paper aims to explore the health effects of hard water and its components.

### Introduction

In a water molecule two hydrogen atoms are bonded covalently with an atom of oxygen by sharing of electrons between atoms. Water is an excellent solvent used by living things because many biochemical reactions are taken place only in aqueous solutions. Water can dissolve many different types of substances because of its ability to form hydrogen bond and its polar nature. Rain water and treated water is soft water which contains low concentration of calcium and magnesium ions and produces lather easily with soap. Hardness is the physico-chemical property of water which prevents lather formation with soap due to presence of high mineral contents. Hard water is formed when water percolates through deposits of calcium and magnesium minerals such as sea water, river water and tap water. Hardness of water is classified into two types, carbonate and non-carbonate hardness. Carbonate hardness also called temporary hardness is due to the presence of bicarbonate and carbonate salts of calcium and magnesium. It can be removed by boiling water. Non-carbonate hardness also known as permanent hardness is due to the presence of calcium chloride, magnesium chlorides and magnesium sulphate.

Scientific studies reported that the minerals present in hard water react with soaps to form a scum like substance that can clog pores and the result may be dry skin, eczema, dandruff, damaged hair. Kobayashi, a Japanese chemist, was first to describe the relation between water hardness and the incidence of vascular disease.<sup>[1]</sup>

### Sources of Hard Water

We know that what are the sources of drinking water in India such as wells, hand pumps, bore wells and tube wells and surface water sources like rivers and lakes. Hard water is caused by the presence of high amount of dissolved minerals and impurities picked up by it when it travels through the ground. When water moves continuously through soil and rocks on our earth, it gets contaminated by the absorption of high mineral contents and becomes hard water. Calcium and magnesium salts, dissolved other metal salts, bicarbonates, silicates and sulphates are governing causes of hardness of water. Hard water is defined as water that contains soluble salts of calcium and magnesium as Bicarbonates, Chlorides and Sulphates. Types of water hardness Water hardness is of two types: temporary hardness and permanent hardness. Temporary stiffness is caused by the soluble calcium and magnesium salts present in the water as bicarbonates. This type of hardness, also

called carbonate hardness can be removed by boiling the water. Boiling the water assists the reaction liberating carbon dioxide which drives off and the carbonate ion reacts with Ca<sup>2+</sup> or Mg<sup>2+</sup> ions to form insoluble calcium and magnesium carbonates which filter out and available water is become soft.



Persistent hardening is due to the presence of soluble chlorides and calcium, magnesium and Sulphates in the water and these can't be removed by boiling water. There are several ways to remove permanent stiffness in water, such as Calgon method, ion exchange method, soda bath method etc.

### Effects of hard water on health

The hardness of water is harmful to the boilers and hot water pipes as the deposition of salts occur, which can reduce their efficiency. The hard water is not good for washing as it is difficult for hard water to form lather with soap. The World Health Organisation states that hard water has no known adverse health effects.<sup>[2]</sup> There is no serious health effects associated with drinking hard water. However solid water acts as a dietary supplement as it contains calcium and magnesium that strengthens bones and teeth.<sup>[3]</sup> Hard water contains high concentration of dissolved minerals therefore millions of people think that these dissolved minerals have positive effects on the health of its drinkers. Many studies suggested that calcium and magnesium present in hard water may act as protective factors against cardiovascular diseases.<sup>[4]</sup> Consumption of hard water can give to dry skin and hair.<sup>[5]</sup> Studies have been conducted on health effects of hard water. It has been reported that drinking hard water might link to the formation of conditions of certain diseases. Hard water can change the pH balance of the skin leaving our skin less healthy than before. Hence people with skin disease may find their disease condition increasing when they wash with hard water. The pH ranges from 0 to 14 indicates how acidic or alkaline the substance is. Acidic water has pH less than 7 and alkaline water has pH greater than 7 and neutral pure water has 7 pH value. The pH balance of skin can be changed due to use of hard water, which decrease the protective strength of skin against bacteria and infections. The skin problems are caused by the presence of excessive minerals in the water. About 80 percent of disease in developing countries is caused by consuming contaminated water, yet many of the households across the country do not treat their drinking water. The Bureau of Indian Standard (BIS) has developed a

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guide for safe drinking water.<sup>[6]</sup> According to the Central Ground Water Board, the BIS have protocol specifications for monitoring the level of drinking water as figure<sup>[7]</sup> no. 2. Several studies reported that sore throats and kidney problems have been observed due to the regular consumption of hard water for a very long time.<sup>[8 & 9]</sup> The World Health Organization confirms the harmful effects of the constant use of hard water on the cardiovascular system. The human body gets calcium and magnesium from organic compounds of food but hard water contains inorganic compounds of these elements, and hence they are absorbed unacceptable. As a result, accumulation of excess salts in the joints may happen and thus problems of the musculoskeletal system.<sup>[10]</sup> Dangerous bacterial growth in drinking water carrying pipes due to hard water scale deposits is very harmful for human health because the scale deposits have an uneven, rough surface which are a perfect hiding place for bacteria to nest in. Excess calcium present in hard water may cause kidneys work harder to filter, stomach upset, nausea and constipation. Hypercalcemia may interfere functions of brain and heart.

**Conclusion**

Water pollution is an important environmental issue that can be due to many contaminants. Consumption of the polluted water may affect the human health. Although compounds of calcium and magnesium present in hard water are very important elements for the functioning of all living organisms, their excess and inorganic origin have harmful effect on living commodity. Various initiatives have been undertaken by government and non-government bodies to solve water crisis around the country.

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**Figure 1: Water hardness scale**

Grains/Gallon	Mg/l and ppm	Classification
Below 01	Below 17.1	It is Soft
From 1.0 to 3.5	From 17.1 to 60	It is Slightly hard
From 3.5 to 7.0	From 60 to 120	It is Moderately hard
From 7.0 to 10.5	From 120 - 180	It is Hard
From 10.5 and over	From 180 and over	It is Like a stone

Note: one grain per gallon = 17.1 part per million (ppm)

Source: <https://www.edrocorp.com/141104news.html>

**Figure 2: BIS 1500-2012 the acceptable limit of bacteria and other contamination in drinking water**

Parameters	Acceptable limit	Permissible limit in the absence of alternative source
pH Value	6.5-8.5	No relaxation
Turbidity ( NTU unit)	1	5
Total Dissolved solid (mg/l)	500	2000
Total hardness as CaCO <sub>3</sub> mg/l ( Max)	200	600
Total Iron as Fe mg/l ( Max)	0.3	No relaxation
E coli presence / absence	Shall not be detectable in any 100 ml sample	Shall not be detectable in any 100 ml sample
Taste	Agreeable	Agreeable
Odour	Agreeable	Agreeable

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