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Contemporary Issue

Demineralization of drinking water: Is it prudent?

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ARTICLE INFO

Article history:

Received 3 August 2013

Accepted 23 November 2013

Available online 6 March 2014

Keywords:

Water

Demineralization

Health

ABSTRACT

Water is the elixir of life. The requirement of water for very existence of life and preservation of health has driven man to devise methods for maintaining its purity and wholesomeness. The water can get contaminated, polluted and become a potential hazard to human health. Water in its purest form devoid of natural minerals can also be the other end of spectrum where health could be adversely affected. Limited availability of fresh water and increased requirements has led to an increased usage of personal, domestic and commercial methods of purification of water. Desalination of saline water where fresh water is in limited supply has led to development of the latest technology of reverse osmosis but is it going to be safe to use such demineralized water over a long duration needs to be debated and discussed.

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Water is the elixir of life. Requirement of water for the very existence of life and preservation of health has driven man to devise methods for maintaining its purity and wholesomeness. The water can get contaminated, polluted and become a potential hazard to health. Water in its purest form devoid of natural minerals can also be the other end of spectrum where health could be adversely affected. Limited availability of fresh water and its increased requirement has led to an increased usage of personal, domestic and commercial methods of purification of water. Desalination of saline water, where fresh water is in limited supply, has led to the development of the latest technology of reverse osmosis but, whether it is going to be safe to use such demineralized water over a long duration, needs to be debated and discussed.

WHO has been updating quality parameters for drinking water and setting guidelines for the same. Maximum acceptable concentrations of inorganic and organic substances and microorganisms have been established internationally and in many countries to assure the safety of drinking water. WHO guidelines on various parameters for drinking water quality

are laid down in standard references.^{1–4} The Indian standards of drinking water have been laid down as per IS 10500:1991, Ed 2.1 published by Bureau of Indian Standards.⁵

Earlier artificially produced demineralized or de-ionized or reverse osmosis (RO) treated water had been used mainly for industrial, technical and laboratory purposes and use of water intended for drinking commonly was not in practice. During the last three decades, demineralization/desalination has become a widely practised technique in providing new fresh water supplies. However desalinated water may vary widely in composition because of numerous existing facilities were developed without compliance with any uniform guidelines and quality control for final product in terms of minimum TDS (total dissolved solids) contents and other minerals. There are now many RO plants operating in civil areas as small scale cottage ventures. These installations and selling of processed water is a low cost, high profitability business. Moreover, lack of proper guidelines for installation, operating standards, maintaining and evaluation of the processed water by any statutory agency is further encouraging this practice.

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<http://dx.doi.org/10.1016/j.mjafi.2013.11.011>

Minerals in drinking water

There are 21 mineral elements known or suspected to be essential for humans of which fourteen mineral elements are established as being essential for good health. These elements in combined form affect bone and membrane structure (Ca, P, Mg, F), water and electrolyte balance (Na, K, Cl), metabolic catalysis (Zn, Cu, Se, Mg, Mn, Mo), oxygen binding (Fe), and hormone functions (I, Cr). Health consequences of micro-nutrient deficiencies include increased morbidity, mortality due to reduced immune defense systems and impaired physical and mental development. Drinking water supplies are highly variable in their mineral contents. While some contribute appreciable amounts of certain minerals either due to natural conditions (e.g., Ca, Mg, Se, F, Zn), intentional additions (F), or leaching from piping (Cu), most provide lesser amounts of nutritionally essential minerals.

Minerals in water and health: the debate

The potential for adverse health effects from long-term consumption of demineralized water is of interest not only in countries lacking adequate fresh water but also in countries where some type of home water treatment system are used or where some type of bottled water are consumed.

For health calcium and magnesium are both essential elements. Although drinking water is not the major source of our calcium and magnesium intake, the health significance of supplemental intake of these elements from drinking water may outweigh its nutritional contribution expressed as the proportion of the total daily intake of these elements. Even in industrialized countries, diet that is not deficient in terms of the quantity of calcium and magnesium may not be able to fully compensate for the absence of calcium and in particular, magnesium in drinking water.⁶

Demineralized soft water, when used for cooking is known to cause substantial losses of all essential elements from food (vegetables, meat, cereals). Such losses may reach up to 60% for magnesium and calcium or even more for some other microelements (e.g., copper 66%, manganese 70%, cobalt 86%). In contrast, when hard water is used for cooking, the loss of these elements is much lower, and in some cases, even higher calcium content was reported in food as a result of cooking.^{6–9} Since most nutrients are ingested with food, the use of low-mineral water for cooking and processing food may cause a marked deficiency in total intake of some essential elements that was much higher than expected with the use of such water for drinking only. The current diet of many persons usually does not provide all necessary elements in sufficient quantities, and therefore, any factor that results in the loss of essential elements and nutrients during the processing and preparation of food could be detrimental for them.

Recent studies also suggest that the intake of soft water, i.e. water low in calcium, may be associated with higher risk of fracture in children, certain neurodegenerative diseases, pre-term birth and low weight at birth and some types of cancer. In addition to an increased risk of sudden death, the intake of

water low in magnesium seems to be associated with a higher risk of motor neuronal disease, pregnancy disorders (so-called preeclampsia) and some types of cancer.¹⁰

Drinking water soft or hard has been a subject of debate and discussion and controversies. Extremes of both are neither good for health nor acceptable by peoples primarily on grounds of taste. The amount of TDS and hardness has effect on taste of water. Water with low TDS is flat and insipid while with high TDS (>2000 mg/L) become objectionable and unpalatable. The palatability with TDS level up to 600 mg/L is considered good.⁶ Aggressive advertisement driven marketing strategy has lured more and more people to use bottled water instead to use it as an alternative when access to safe water is not feasible in situations like traveling, camping, tracking or during mil operations. Expert Consensus Meeting Group Report on potential health consequences of long-term consumption of demineralized, remineralized and altered mineral content drinking water has concluded that the hypothesis that consumption of hard water is associated with a somewhat lowered risk of cardiovascular disease was probably valid, and that magnesium was the more likely contributor of that benefits.¹¹

Armed Forces perspective

The responsibility of providing safe water is entrusted with PHED (public health engineering department) in civil and to MES in peace (Military Engineering Services) in the armed forces and field engineers in the field setting. These authorities are responsible for supplying adequate quantity of water and assisted by medical authorities to monitor and maintain quality of water, chemically and microbiologically by carrying out periodic tests. In geographical areas where water is hard and saline, water is subjected to demineralization by appropriate technique to bring the mineral contents within normal specification as laid down by WHO. The chemical analysis of water is also carried out initially on commencement of new source and there after periodically to ascertain mineral content in water.

In the armed forces the influence of advertisements, propaganda and persuasion by companies, or on the name of welfare of men, there is an increasing tendency to allow private vendors to operate RO plants in garrison or cantonments, to supply drinking water as alternate source even when mineral contents of water is well within normal limits. Subjecting this water (having TDS within normal limits) to demineralization/reverse osmosis will further deplete the water of its minerals content and make it soft. At two garrisons, where RO plants are operated by a local vender, TDS of processed water was measured by a digital TDS meter. The TDS in processed water ranged from minimum 50 ppm to maximum 180 ppm with mean 124 ppm. This means that processed water is practically soft water and devoid of its mineral contents (normal value of TDS being 500–2000 ppm).⁵ Consumption of such water in long run is bound to have deleterious effects on the health of the consumers. This processed water has no residual chlorine and stored or dispensed in PVC can/bottles provides no protection against probable microbial contamination due to handling which is taken care

of in conventional system of water supply having free residual chlorine.

Recommendations

As medical authorities we should advise and persuade administrative authorities to discourage tendencies of installing desalination/RO plants in the name of welfare or on demand of ill-informed clientele on the sake of “water fad” (without having scientific basis) to protect people from chronic diseases. The requirement of these should be assessed taking into consideration of geological parameters and chemical report of available water source in the area and be installed through authorized agencies with inbuilt mechanism for control, monitoring and evaluation of quality of processed water to safe guard health of the personnel in longer run. The use of conventional treatment techniques like chlorination has stood the test of time besides offering many advantages over newer technology, which produce demineralized water. Besides being cheap, its easy application in all climates and terrains, residual effect, easy monitoring of using chlorine gas remains the best option for the Armed Forces both in peace and field. There is however a need for a larger study which can be undertaken to study the water supply and treatment systems in all the three services and weigh the conventional systems of chlorination vis-à-vis the emerging methods and specifically the RO water plants taking into account the efficiency, cost effectiveness and user perspective on water safety.

Conflicts of interest

All authors have none to declare.

REFERENCES

1. *Surveillance and Control of Community Supplies* Guidelines for Drinking Water Quality; vol. 3. Geneva: WHO; 1997.
2. *Recommendations* Guidelines for Drinking Water Quality; vol. 1. Geneva: WHO; 1993.
3. *Health Criteria and Other Supporting Information* International Programme on Chemical Safety. Guidelines for Drinking Water Quality; vol. 2. Geneva: WHO; 1996.
4. ICMR Report No 44. *Manual of Standards of Quality for Drinking Water*. Indian Council of Medical Research. Govt. of India; 1975.
5. IS10500: 1991 Edition 2.1. *Indian Standard Drinking Water Specification (First Revision)*. Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi: Bureau of Indian Standards; 2003.
6. Kozisek F. *Health Risk from Drinking Demineralized Water*. Rolling Revision of the WHO Guidelines for Drinking Water Quality. 2004;8–9.
7. *Working Group Report (Brussels, 20–23 March 1978)*. Health Effects of the Removal of Substances Occurring Naturally in Drinking Water, with Special Reference to Demineralized and Desalinated Water. EURO Reports and Studies 16. Copenhagen. Geneva: WHO; 1979.
8. Haring BSA, Van Delft W. Changes in the mineral composition of food as a result of cooking in “hard” and “soft” waters. *Arch. Environ Health*. 1981;36:33–35.
9. Oh CK, Lückner PW, Wetzelsberger N, Kuhlmann F. The determination of magnesium, calcium, sodium and potassium in assorted foods with special attention to the loss of electrolytes after various forms of food preparations. *Mag Bull*. 1986;8:297–302.
10. Durlach J. The importance of magnesium in water. In: Durlach J, ed. *Magnesium in Clinical Practice*. London: John Libbey & Co Ltd; 1988:221–222.
11. *Expert Consensus Meeting Group Report*. Nutrients in Drinking Water. Potential Health Consequences of Long-Term Consumption of Demineralized, Remineralized and Altered Mineral Content Drinking Water. Geneva: WHO; 2005.