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## **Health Risks from Long Term Consumption of Reverse Osmosis Water**

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### **Abstract**

The popularity of reverse osmosis (RO) water has been steadily increasing since it was first introduced as a home water purification system in the 1970s. Even the bottle water companies are also using reverse osmosis water these days. Reverse Osmosis (RO) is a membrane based process technology used for desalination of water to make it drinkable. The RO water purification method involves the process of forcing the water through a semipermeable membrane, which filters out contaminants larger in size than water molecules. The most mineral particles that are required by our body such as sodium, magnesium and iron are larger in size than water molecules and get removed from water by semipermeable membrane of the RO system thus render water unhealthy for consumption. The World Health Organisation has conducted a study which exposes some of the health risks associated with demineralised drinking water. Some of the health risks associated with consuming reverse osmosis water are discussed here.

### **INTRODUCTION:**

Drinking water supply comes from ground and surface water sources. As per drinking water regulations municipalities are required to treat and disinfect drinking water before distributing it to public due to the possibility of the presence of micro-organisms, toxic minerals, metals, organic chemicals, pesticides etc. Improperly treated drinking water is responsible for causing a number of diseases. The guidelines about drinking water standards are given by World Health Organisation and European Union [1].

Actually all substances present in water are not harmful to our health, some of them are not harmful to our health. Some of them are health improving too. The water

almost or completely free of dissolved minerals as a result of deionisation, distillation, reverse osmosis or other technologies is called demineralised water. There are many pros and cons on drinking demineralised water. The arguments favouring drinking demineralised water is that the minerals present in water interfere with our body functions. Many articles written by doctors or nutritionists claim that the presence of minerals in drinking water cause diseases like occurrence of cardiovascular diseases, diabetes, cancer, respiratory diseases etc. The argument against drinking demineralised water are that by distilling or reverse osmosis we have lost a primary source of necessary minerals in our diet and that the water has lost its own minerals will attract and absorb minerals in our body resulting in deficiency of minerals[2].

The importance of minerals and other beneficial constituents in drinking water is even mentioned in Rig Veda in which properties of good drinking water are described as, “ Sheetham (cold), Sushihi(clean), Sivam(should have nutritive value and required minerals), Isthamb(transparent), Vimalam Lahu Shadgunam(its acid base balance should be within normal limits). Initially demineralised water, first distilled water, later deionised or reverse osmosis treated water had been used for laboratory, technical and industrial purposes. These technologies became more extensively used for obtaining drinking water in 1960s due to limited drinking water sources in coastal and inland areas, the increasing drinking water demands resulting from increasing populations, higher living standards, development of industries and mass tourism. Demineralisation of water was also required in the areas where the water sources are sea water or highly mineralised brackish water. Demineralised water was also used in ocean going ships and spaceships where this was the only source of drinking water. Initially these water treatments were not used at homes since they were costly, but with improvement of economic status, these days RO system has become an essential gadget at the homes of even middle class in India in addition to higher class.

Demineralised water is defined as water almost or completely free of dissolved minerals, obtained by distillation, deionisation, reverse osmosis or Nano filtration etc. The total dissolved solids (TDS) in this water is quite low approximately 1mg/l. From the beginning it was clear that demineralised water without further addition with some minerals might not be fully suitable for consumption due to following reasons.

1. Demineralised water is highly aggressive and if some useful minerals are not added, it attacks the water distribution pipes and storage tanks thus leaches metals and other materials from pipes and other plumbing materials.
2. Demineralised water has poor taste usually bitter.
3. Evidence was available that some substances present in water could have beneficial effects on human health. For example artificially fluorinated water resulted in decrease of tooth caries.

The potential for adverse health effects from long term consumption of demineralised water is of concern not only in countries which lack adequate fresh water, but also in countries where such types of home water treatment systems or bottled water are widely used. So the exposures and risks should be considered not only at community level but also at the individual or family level.

**HEALTH RISKS FROM CONSUMPTION OF REVERSE OSMOSIS WATER:**

Review of some experimental facts obtained from the experiments conducted on laboratory animals and human volunteers and observations obtained from populations supplied with demineralised water and infants given beverages prepared in distilled water, the possible harmful effects of reverse osmosis water consumptions are discussed here.

**Low or no intake of magnesium and calcium from low mineral (RO) water:**

Calcium and magnesium are essential elements for our body. Calcium is part of our bones and teeth. It is also important in conducting myocardial system, heart and muscle contractibility, blood clotting etc. The most common disease caused by calcium deficiency is osteoporosis. Its deficiency has also been proved to cause hypertension [4].

Magnesium plays an important role in glycolysis, ATP metabolism, transport of elements such as potassium, sodium and calcium through membranes, synthesis of proteins and nucleic acids, muscle contraction etc. Its deficiency increases the risks to humans of developing various pathological conditions such as hypertension, cardiovascular diseases, vasoconstrictions, diabetes and osteoporosis etc. [5].

It has been found that drinking water low in magnesium for long term can cause increased morbidity and mortality from cardiovascular diseases, risks of motor neuronal disease, pregnancy disorder etc. Water low in calcium taken for long duration of time causes high risk of fracture in children, certain neurodegenerative diseases, preterm and low weight birth etc. Deficiency of both magnesium and calcium in drinking water can also cause some types of cancers [8].

**Direct effects of low mineral (RO) water on the intestinal mucous membrane:** It has been reported by WHO and other studies that drinking of demineralised water can cause electrolyte imbalance in body as all the minerals from such water are filtered off by semipermeable membrane in reverse osmosis or removed by distillation in distilled water. So this mineral free water in our body leaches electrolytes from our tissues, so that our body can function normally and can eliminate waste. If water redistribution process in our body is not functioning properly, one may feel fatigue, muscle cramps, weakness, headache and abnormal heart rate. In the past, acute health problems were reported in mountain climbers who used to drink water from melted snow that was not supplemented with necessary ions. More severe health problems arising from such condition are brain oedema, convulsions, metabolic acidosis etc. [9]

**Low intake of essential elements and micronutrients consuming RO water:** Some essential elements are usually present in natural water as free ions and they are readily absorbed from water as compared to food. The epidemiological studies suggests that lower mineral drinking water leads to hypertension, coronary heart disease, pregnancy complications, gastric ulcers, goitre, jaundice, anaemia, fractures, growth disorders etc.

In laboratory rats, it has been found to result in much lower levels of microelements in muscular tissue and have negative effect on the blood formation process.

A study was conducted by Lutai in 1927, on two populations living in areas with different levels of dissolved minerals which have shown that the population of area supplied with water low in minerals had higher incident rates of these diseases. Children in this area exhibited slower physical development, growth abnormalities and the pregnant women suffered more from oedema and anaemia than those living in areas provided with water moderate in minerals [10-13].

**Loss of calcium, magnesium and other essential elements in food prepared in low mineral water:** When demineralised water is used for cooking, it results in a great loss of essential elements from food i.e. about 60% magnesium and calcium, 70% manganese, 86% cobalt, 66% copper etc. However these losses in metal contents are not reported when the cooking is done in natural water. Since some nutrients are only ingested with food, low mineral water used for cooking may take away these nutrients from food and results in a striking deficiency in these elements. So any factor that causes the loss of essential elements and nutrients during cooking and processing of food should be avoided as the diet these days taken by us already do not provide necessary elements in sufficient quantities [14-15].

**Possible increase in dietary intake of toxic metals:** Demineralised water is highly aggressive to materials it comes into contact with. So it readily dissolves metals and organic substances from the pipes, storage tanks, containers and other plumbing materials and thus it becomes contaminated. Thus the act of cleaning water with RO may end in addition of more harmful substances. Calcium and magnesium present in water and food have been found to have antitoxic activity and hence they can prevent the absorption of some toxic elements from the intestine into blood [16, 17].

**Bacteria contamination of low mineral RO water:** In reverse osmosis process bacteria get filtered out by semipermeable membrane because of their usually larger size than the pores of the semi-permeable membrane and thus are drained out with waste water which is then rejected by the system. But, it is significant to point out that reverse osmosis drinking water systems are not bacteria proof. The system may have exposure to some bacteria prevailing in the environment. Bacterial contamination may occur during the actual processing of water in the system. The RO membrane can have defects making bacteria able to pass through it. Bacteria may sometimes enter the water through the seal that holds the RO membrane which then flourish in low mineral RO water due to the lack of a residual disinfectant present in natural water and great availability of leached nutrients. The regrowth of bacteria is encouraged in RO water due to the lack of a residual disinfectant present in natural water and great availability of leached nutrients in aggressive water particularly when it has high temperature [18, 19]. So in addition to reverse osmosis, we should also use ultraviolet purification system to eliminate bacteria completely from our water. There are reverse osmosis/ultraviolet combined systems that are these days designed to confirm that no bacteria enter into drinking water.

**High acidic nature of demineralised water:** As demineralised water contains no minerals, it absorbs other elements very easily. Theoretically, demineralised or reverse osmosis water should be neutral with pH value of 7. But, such water is

unstable in nature and hence readily absorbs carbon dioxide in the air when it comes in contact with air which makes the water acidic, hence more corrosive to pipes and storage tanks. Freshly demineralised water may reach pH as low as 5.5 in a short time. Acidic water is not healthy for drinking as it can lead to imbalance of pH in blood, which should be alkaline.

In the natural health and medical communities, acidosis in the body is considered an underlying cause for most of the degenerative diseases [20]. Dr. Otto Warburg won the Nobel Prize, in 1931 for discovering the cause of cancer. According to him cancer was caused by a lack of cellular oxygenation due to acidosis in the body. It has also been determined in various medical researches that drinking acidic water as well as other acidic beverages often cause an imbalance of minerals in the body.

Low mineral water increased diuresis i.e. the production of urine by the kidneys by 20% on average and significantly increased the elimination of sodium, potassium, calcium magnesium and chloride ions from the body as reported by WHO in a study.

**Poor taste:** Low mineral water or reverse osmosis water has low TDS so it tastes bitter. The demineralised water with a TDS of 25-50 mg/l has been described as tasteless by the World Health Organisation (WHO) in 1980, based on a study report. (WHO 2004 paper). RO water purifier manufacturers have become aware of this problem so these days some RO water purifiers have been fitted with a Cartridge called a remineraliser cartridge which is filled with purified alkali essential mineral salts of Calcium and Magnesium, through which the pure RO water is made to pass. As a result the pure RO water dissolves some of the essential minerals from this remineralisation cartridge to give RO water which does not taste bitter, have some essential minerals and is alkaline. However even this remineraliser cartridge cannot add all the essential nutrients present in natural water.

**Less thirst reducing:** Demineralised or reverse osmosis water is less effecting in satisfying thirst than water rich in minerals. (WHO 2004 paper) As a result lesser amount of water is consumed and hence tempts consumers to take other less healthy beverages such as soft drinks, carbonated water, tea, coffee etc. which adds to their calorie intake leading to obesity and in turn to many diseases.

**Some critical contaminants are not removed:** Reverse osmosis is effective for removing most of the contaminants from water but it alone does not remove volatile organic compounds (VOC), chlorine, chloramines, pharmaceuticals and other chemicals found in municipality water. The RO's efficiency to remove contaminants from water depends upon the concentration and chemical nature of contaminant, nature of membrane and the operating conditions. But these days R.O. systems have multistage filtration media, such as activated carbon, in addition to R.O. membrane which removes chlorine, VOC and certain pesticides [20].

**Dental health:** Reverse Osmosis also removes fluoride that natural water contains. Lack of fluoride in drinking water causes tooth decay and cavities in children. Some dentists relate the lack of fluoride in drinking water as a cause of an increased number of cavities in young children who consume distilled, RO or demineralised water [21].

### **VARIOUS RESEARCHES ON HARMFUL EFFECTS OF CONSUMING LOW-MINERAL WATER TO HUMAN POPULATIONS AND TO CROPS**

Epidemiological studies in many countries all over the world since the early 1960's, have reported that water low in minerals especially calcium and magnesium is responsible for rise in morbidity and mortality from cardiovascular disease.

Epidemiological studies were conducted among Russian populations, in the Ust-Ilim region of Russia in 1992 [22]. People in these two regions were provided with either low-mineral water or normal water. The study mainly focused on the morbidity and physical development of 7,658 adults, 562 children, 1,582 pregnant women and their infants and new-borns (WHO 2004 paper). People who were provided with low-mineral water suffered from higher risks of hypertension, coronary heart diseases, chronic gastritis, goitre, gastric and duodenal ulcers, pregnancy complications and many types of complications in new-borns and infants including anaemia, jaundice, fractures and growth disorders. (WHO 2004 paper)

Effect of short-term consumption of low mineral water were observed in the Czech and Slovak populations who started using reverse osmosis-based systems for final treatment of drinking water at their home taps in 2000-2002. Various health problems indicative of acute magnesium and calcium deficiency were reported within several weeks or months. Among these were cardiovascular disorders, weakness, tiredness and muscular cramps [23].

It was reported in a multi-city study that the women living in cities supplied with low-mineral water showed cardiovascular changes in their ECG, higher blood pressure, headache, dizziness, and osteoporosis more frequently as compared to those living in cities which were supplied with higher mineral content water [24-25].

It was reported by the researchers in Israel that low-mineral water used for agricultural irrigation has harmful effects on crops. Israel is a world innovator in using desalinated water in farming. Calcium deficiency has been observed to cause physiological defects, whereas magnesium shortage harms plant development. The predominantly significant harmful effects are found to be to the crops such as tomatoes, basil and certain species of flower are.

After analysing several scientific studies regarding demineralised or reverse osmosis water, the World Health Organization released a report stating that such water "has a definite adverse influence on the animal and human organism." Thus provided various norms about the safe drinking water [26].

### **The WHO provided recommendations in 2004 for the drinking water mineral content standards:**

1. For magnesium, a minimum of 10 mg/l and an optimum of 20-30mg/l.
2. For calcium, a minimum of 20mg/l and an optimum of about 50mg/l.
3. For total dissolved salt concentration (TDS), the sum of calcium and magnesium should be 2 to 4 mmol /l.

At these concentrations no adverse health effects were observed. The recommended magnesium levels were based on cardiovascular system effects, while changes in calcium metabolism and ossification were used as a basis for the calcium levels (WHO paper 2004).

## **CONCLUSION:**

RO systems are doing a great work of removing impurities/ contaminants from the water but the problem with RO systems is that they do not discriminate between the good and bad minerals as they remove everything. So the need is to remineralise the water once it has passed through the RO membrane. So adding back the calcium and magnesium in proper concentration solves the problem.

RO industry has become aware of the reality that long term consumption of demineralised water is not good for health. They are also trying to find solutions to make their RO filtered water healthy. Initially some industries offered corosex and calcite solutions. Though corosex and calcite will remineralize water but they were not designed to work with the aggressive acidic water produced by RO system. Hence corosex and calcite minerals can dump more minerals into water than our kidneys can digest and end up in the formation of kidney stones. So corosex and calcite are not the right solution for remineralization of aggressive acidic water produced by RO machines. These days Nano filtration and ultrafiltration is gaining the rapport as these filters are cost effective, much smaller and allow faster flow of water.

The filter required depends upon the source of your water. For the water supplied by municipality does not require to be cleaned by RO system unless the municipality adds fluoride to it.

There is a new water filter ( made in America) which is consist of two types of filters, activated carbon and zeolite minerals bound with polymers to form a carbon block. It removes 85% of fluoride at the rate of water flow rate 2 litres per minute and 95% if flow rate of water is reduced to 1 litre per minute. So problem of mixing of fluoride by municipality in water supply can be solved.

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