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Production Sources and Potential Applications of Alkaline Water

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Abstract:
Water is an essential part of the human body and makes up 70% of body weight. Water is necessary to sustain life on earth. Drinking water comes in different forms, and alkaline water is one of the most recent additions. Alkaline water has a pH in the range of 8-10 and contains minerals that provide several health benefits to the body on consumption. This review article revolves around alkaline water and its benefits to the human body. The main objective is to provide awareness among people about alkaline water consumption, its production method, and its beneficial effects on the body of humans. All the data has been collected by studying various journals and articles. It is recommended that further research be conducted to learn more about the benefits, daily usage of alkaline water, and role of alkaline water in treating different diseases like acid reflux, diabetes, cancer, etc.

Keywords: Alkaline water, pH, Human body makeup

1. INTRODUCTION

Alkaline compounds (alkali) are substances, like salts, metals, and minerals, that make it more basic when added to water.[4] Water always contains some number of dissolved solids, including minerals like Calcium, Magnesium, Potassium, and Sodium, but alkaline water tends to have a higher amount of total dissolved solids, which increases its pH level than regular drinking water. The health benefits of consuming eight glasses of water daily are no longer hidden today. Water is a basic necessity of all living organisms. It is essential for all the body's organs, tissues, and every component of body cells. Staying hydrated has many benefits, such as shiny and fresh skin, increased energy levels and good heart health [1].

1.1 Water not only quenches the thirst but is also essential to keep the body functioning healthy.

It is true from all aspects of the daily that by drinking alkaline water, many health benefits may be gained. It keeps the body less acidic. Studies showed that it seems appealing to people that the body remains more alkaline and less acidic [2]. So, alkaline water is healthier for the body than simple or taped water [3]. Alkaline water, sometimes called alkaline ionized water (AKW), is widely available and usually recommended for electrolyte replacement during intense exercise. The effects of alkaline water on child development and body weight improvement have been demonstrated in early animal models [4].

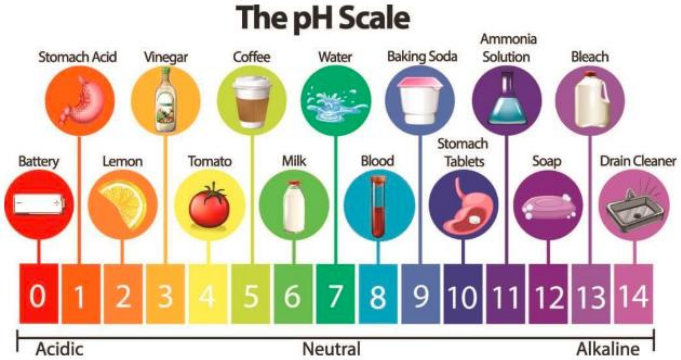

Figure 1: pH Scale [5]

1.2 How does alkaline water differ from simple water?

Normal water, which is consumed daily, consists of H and O with a pH of 7, which is neutral, neither acidic nor basic, while on the other hand, typically alkaline water has a pH of 8-9 [6]. Some other minerals impart alkalinity to water along with oxidation-reduction Potential (ORP). The Oxidation Reduction Potential refers to its antioxidant or pro-active properties.

Negative ORP values enhance antioxidant properties. According to EPA guidelines, water should have a pH of between 6.5 and 8.5. Depending on whether the water claims to be alkaline, it is subject to different standards. There is a pH level above 7 in bottled alkaline water. A special device used by manufacturers can alter the chemical composition of water. In other cases, they change the pH of the water by adding nutrients.
Here (Table 1) is the list of Common water pH:

Table 1. The list of Common water pH Cirino, [6]

Type of water	pH level
Tap Water	Varies; typically, about 7.5
Distilled reverse osmosis water	5 to 7
Common bottled water	6.5 to 7.5
Bottled water labelled as alkaline	8 to 9
Ocean water	About 8
Acid rain	5 to 5.5

1.3 Minerals content of alkaline water:

Alkaline water contains minerals like Calcium, Potassium, Magnesium, and Sodium. These minerals provide several health benefits to the body.

1.3.1 Calcium:

Calcium is the most important mineral for the human body. It is added to alkaline water in the form mineral concentrate mix. Calcium helps in regulating blood pressure, promotes bone health, and prevents diseases like osteoporosis. Calcium supplementation prevents developing polyps, which cause cancer and reduces the parathyroid hormone in people having kidney failure [8]. Moreover, it circulates the blood, moves the muscles, strengthens bones, and releases hormones [8].

1.3.2 Potassium:

Potassium is an important mineral for the human body. It is added to alkaline water in the form of a mineral concentrate mix. It helps in the proper functioning of nerves and muscles and plays a vital role in synthesizing protein and metabolizing carbohydrates. Our body needs it for the proper functioning of cells. It helps in preventing high blood pressure and stroke and promotes kidney health. Potassium intake helps to maintain bone mass and manage blood pressure [10].

1.3.3 Magnesium:

Magnesium is an important mineral and plays many vital roles in the human body. Like Calcium and Potassium, Magnesium is also added to alkaline water as a mineral concentrate mix. It plays a vital role in glucose control and insulin metabolism, thus helping in preventing the risk of getting diabetic. It maintains the muscle's health, including the heart's muscles and helps lower mood disorders [11].

1.3.4 Sodium:

Sodium in our body performs so many principal functions. Although required in small quantity, yet is so necessary for the normal function of our body. It helps in muscle contraction and relaxation and is also required for conducting nerve impulses. Sodium maintains the balance between water and minerals in the body. The Sodium regulates fluid balance, prevents sunstroke and plays a key role in normal nerve and muscle functioning [12]

1.3.5 Production of alkaline water:

Alkaline water is under discussion nowadays because some health professionals claim that alkaline water gives you various health benefits like regulating body PH, slowing the aging process, and preventing chronic diseases like cancer [12]. However, few people know about the method of production of alkaline water. Alkaline water is produced by natural and artificial methods.

1.4 Natural alkaline water production:

Natural alkaline water is produced naturally when water flows down the streams of mountains or ice from glaciers melt, and water runs down through the waterfalls; it traps the minerals from the rocks through which it runs. Due to mineral trapping, the PH of water rises, making it naturally alkaline [14].

1.4.1 Artificial alkaline water:

Artificially alkaline water is produced by two procedures. One is by using additives, and the other one is by electrolysis using electrolyzing machines.

1.4.2 Using additives:

This method is a cheap and easiest way of producing alkaline water. Following additives can be usedfor this purpose. But

still, this method does not add enough mineral content to water. So, producing alkaline water throughthis method is still arbitrary.

1.4.3 Using electrolysis:

Alkaline water electrolysis (AWE) is a safe technology and is being used in many industries. The modern method of producing improved alkaline water includes the electrolysis step. Electrolysis is conducted by using electrolysis cells. Each cell has an anode and a cathode chamber, and a diaphragm between the two chambers serves as an ion exchange membrane. The basic function of this membrane is to restrict the water, thereby allowing the ion exchange to take place. The cathode and anode chambers are made of platinum or carbon. An anode is connected to the positive terminal of DC voltage and is called an anodic chamber. The cathode is connected to the negative terminal of DC voltage and is called a cathodic chamber. This generates the electric field between two terminals. Carbon dioxide with electrolytic salt of ammonium acetate (CH_3COONH_4) may be added if necessary. The electrolysis of water occurs when a high voltage DC is applied between the anode and cathode, and electric current starts flowing between two terminals. Oxygen is generated at the anode surface, producing acidic water of low PH. While in the cathode chamber, alkaline water of high PH is produced. As a result, two streams of water are produced: one is acidic, and the other is alkaline [14]. The following reaction takes place on the anode and cathode:

1.4.4 Cathode reaction:

$$2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$$

$$M + H_2O + 2e^- \longrightarrow MH_{adsorbed} + OH^-$$

1.4.5 Anode reaction:

$$4OH^- \longrightarrow O_2 + 2H_2O + 4e^-$$

1.5 The procedure of production of Alkaline water artificially:

The first step in the production of alkaline water is the portable supply of water. This water may be tap water or, water from a public supply with varying mineral content or water from private or public wells. In the next step, water from any of the above sources is filtered**.** The filtration is conducted in 2 steps. In the first step, water is passed through the sand and gravel filter to remove oxidized metals and large particles from the source water. In the next step of filtration activated carbon filter is used to remove organic material, chlorine, and particles of the selected size. These two stages of filtration remove the particulate matter to the level of 5 microns (Fig.2).

In the next step, acid may be added to the filtered water to lower the pH below 6.7. The benefit of doing this is that it minimizes the ability of potassium carbonate precipitation on the water purification membrane by shifting the bicarbonate concentration in the water towards carbonic acid. However, this step is not necessary. The resultant water is then subjected to reverse osmosis. The reverse osmosis unit is capable of removing different elements like sugars, salts, proteins, and particles of varying sizes, including smaller ions of molecular size greater than 150-250 Daltons. It also removes the odour from the water. In reverse osmosis, a semi-permeable membrane is used to create two streams: water and waste streams. The water stream is the desired purified water. After this step, the purified water typically contains total dissolved solids (TDS) in the range of 1-10 parts per million (ppm) and PH in the range of 5.5-6.5 before electrolytic cell treatment purified water is temporarily stored in the storage tank.

At this point, the pH of filtered water is adjusted by adding an acid and is disinfected with chlorine or by ultraviolet radiation to reduce the colony-forming units (CFU) below the level of 5. The in-line injection system adds the concentrated minerals mix into purified water. The rate at which mineral mix is added depends upon the mineral content of purified water and the desired level of minerals in the final product. Usually, the range of minerals content is between 20-200 ppm. The addition of minerals is important because they give the desired antioxidant effect. Minerals should be alkaline, including Magnesium, Potassium, Calcium, and Sodium. Depending on the desired characteristics of the final products. Vitamins can also be added to purified water. The resultant mineralized water is subjected to electrolysis in an electrolytic cell. The incoming mineralized water is electrolyzed into two streams by electrolyzing cells using an electric current. One is an acidic stream, and the other is an alkaline stream. Mineralized water is directed to both anode and cathode chambers, and water flow in both chambers is adjusted in the range of 1:1, and 25:1.The pH is controlled by adjusting the electrolysis current throughthe cell. A control system is installed, which adjusts the voltage between two electrodes. The desired pH level of mineralized water is achieved by continuously adjusting the current through the cell. 100 amps or more current is usually used to achievethe desired level, which in turn depends upon the flow rate and water conductivity.

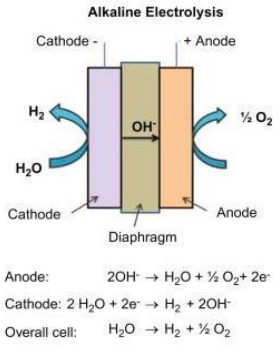

Figure 2: Alkaline electrolysis

The resultant product from electrolytic cell is acidic and alkaline water. The acidic water from the electrolyzing cell has a pH in the range of 5-7. This water is reprocessed. The reprocessed alkaline water has a pH of 9-10, with TDS and alkalinity being increased by 10-30% by incoming water. This resultant water is then subjected to electrolysis and is improved in several aspects, including TDS, alkalinity, and PH. The electrolyzed alkaline water is then stored in a storage tank. The electrolyzed water is again disinfected at to reduce colony forming unit to a level below 3. Disinfection is done by using ultraviolet exposure. After this, bottling and distribution are conducted in the bottling facility. By filtration and purification, purified water is produced that contains less than 6 ppm total dissolved solids, or approximately 98% pure water. The water is re-mineralized and electrolyzed to produce alkaline and acidic water streams. Specific characteristics of the alkaline water stream are preselected with a predefined range of values. The process is controlled so that the alkaline water stream maintains the characteristics selected, as described above (Fig.3).

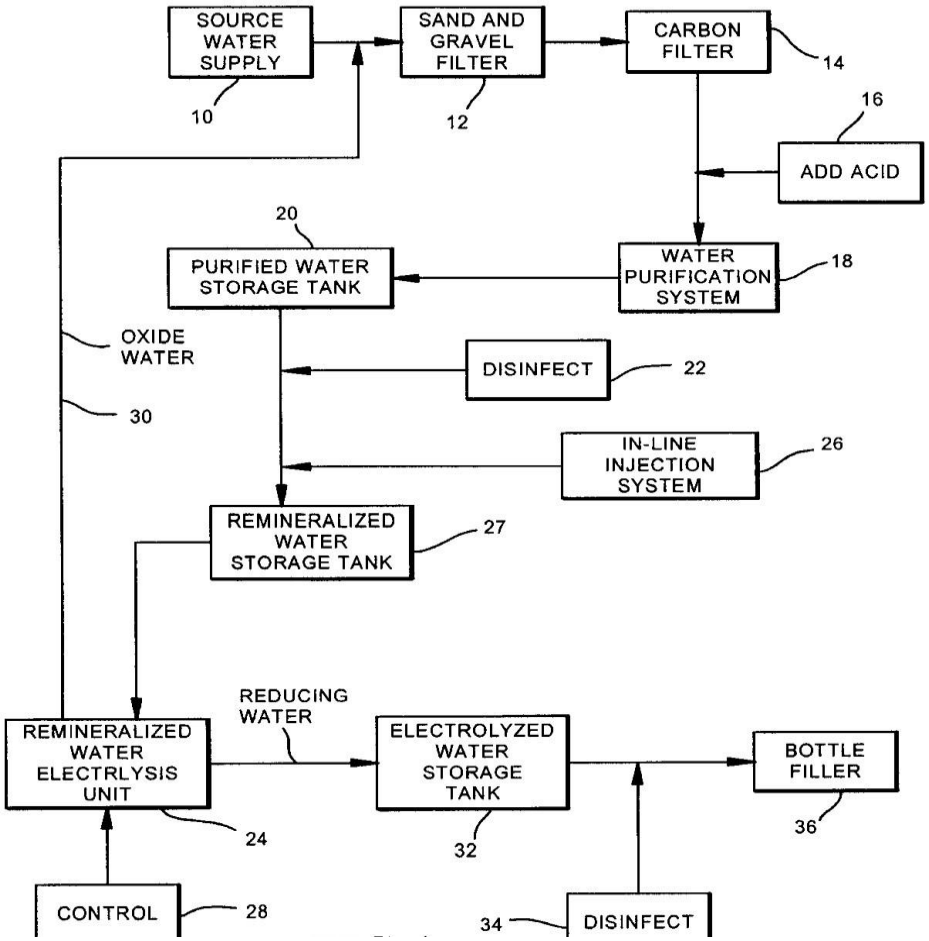

Figure 3. Process of producing improved alkaline drinking water and the product produced thereby.

1.6 Benefits of Drinking Alkaline Water

1.6.1 Good for Osteoporosis and Bone Health:

Some studies and research have done about alkaline water and its effect on bones. According to a published study a process occurs in body known as bone resorption. In it the new bone cells take place and older get broken down. When bone reabsorption takes place at a faster rate and mineral density is less, then results in weak bones. Compared to calcium-rich acidic mineral water, alkaline mineral water with bicarbonate and calcium-rich structures reduced bone resorption. But this only had a minor impact. Research should be conducted to see whether bone mineral density could be improved by less bone resorption in the long run. Another study investigated the effects of an acidic diet against alkaline water on osteoporosis, a condition characterized by fragile bones. Alkaline diets and value-added items combat acidity, assist the body in regulating pH and avoid disease processes. The acid in today's diet does not induce osteoporosis. It concluded that osteoporosis is not prevented by an alkaline diet, alkaline supplements, or alkaline salts [16]. However, the researchers found no proof that this would enhance bone health or help avoid osteoporosis and did not anticipate that this would reflect total calcium levels[16]

1.6.2. Alkaline water is anti-aging:

Aging is a physiological process that proceeds continuously and never stops and affects all living things. Although the prokaryotes, Protozoans, and algae that are fundamentally immortal are excluded from this physiological process since they do not go progressive and continuous process of becoming older day by day [18]

Alkaline water on the other hand, is helpful in reducing the signs of aging. Water makes up over half of the body weight;it is crucial for maintaining the health and proper operation of our organs. According to the Alkaline Water Plus article, "you'd look and feel less youthful and elder if your water level decreased in any specific bodily sections such as skin, muscles, and organs. These specific parts of the body's health would drop." Alkaline water is promoted as having antioxidants that hydrate the body thoroughly and filter out free radicals, slowing down cell ageing by maintaining their health [18]

1.6.3. Helps to treat acid Reflux:

The lower esophageal sphincter, a muscular ring, acts as a valve at the opening to the stomach (LES). The LES typically shuts as immediately as food enters it. The acid released by the stomach may rise into the esophagus if the LES does not completely seal or opens too frequently. This may result in symptoms like heartburn and a burning chest ache. It may cause gastroesophageal reflux disease (GERD), commonly known as acid reflux disease, if symptoms occur more frequently than twice a week [20]. Although the thresholds for laryngopharyngeal harm in laryngopharyngeal Reflux and for esophageal damage in gastroesophageal reflux disease vary, both forms of damage are caused by pepsin, which needs acid for activation. Tissue-bound pepsin is fundamental to the pathophysiologic mechanism of reflux disease. Human pepsin can also be triggered by hydrogen ions from any source and is still stable at a pH of 7.4. Since most tap and bottled waters have a pH of 6.7 to 7.4, it is unlikely that they will have an impact on the stability of the pepsin. Thus, alkaline water with a pH of 8.8 quickly denatures pepsin, making it permanently inert, unlike regular drinking water. It also has a strong acid buffering capacity. As a result, people with reflux illness may experience therapeutic benefits from drinking alkaline water [21].

1.6.4. Lower cholesterol, hyperglycemia, and hypertension:

In 2016, researchers in Shanghai discovered that individuals with increased blood pressure (hypertension), hyperglycemia (diabetes), and elevated blood lipids (cholesterol) had decreased readings of each of these conditions three to six months after consuming alkaline water. After exercise, 100 individuals' blood viscosity, the thickness and stickiness of their blood was found to be lowered by a high-pH electrolyte drink, according to research. This might lessen the stress on the heart brought on by dehydration.

1.6.5 Keeps your energy level up:

Robert O. Young, a co-author of the pH Miracle, claims in a News max health review that having too much acid in the body can cause exhaustion, drowsiness, and a loss of energy. Alkaline water has been proven to be an amazing source for reversing acidic levels in the body, and it can help replenish depleted energy levels [18].

1.6.6. Keeps you more hydrated than normal water:

The question of whether alkaline water is superior for rehydrating after exercise is another crucial one. The idea is that dehydration makes blood thicker or more viscous. Additionally, drinking alkaline water after a workout reduces blood viscosity more effectively than water with a normal pH level. The viscosity was lowered by 6.3% in those who drank electrolyzed, high-pH water after exercise, compared to 3.36% in those who drank ordinary water, according to a frequently cited small research of 100 healthy people. This investigation was modest and constrained. Comparing alkaline water to ordinary water, researchers were able to demonstrate that alkaline water reduced blood viscosity. Their findings were also significant. There is undoubtedly a need for greater study in this area. For cells to move water across cell membranes,

electrolytes are crucial.

Additionally, they manage and maintain the body's fluid equilibrium. The main participants are Sodium, Potassium, Calcium, and Magnesium. After a demanding or perspiration-filled workout, the body lacks many essential electrolytes [22].

1.7 Side Effects

1.7.1 Side effects of alkaline water:

Drinking alkaline water is considered safe. Negative side effects have not yet been demonstrated. However, there is some specification for people having kidney disease. People having kidney disease should avoid drinking alkaline water because of its mineral content. Some studies have shown that the human body produces hydrochloric acid to regulate its stomach's pH levels and maintain homeostasis, a state of stability, even though alkaline water has a different pH than regular water [5]**.** Having a bottle of alkaline water every day will not have a significant impact on the body, but drinking a gallon or more daily might disrupt the pH balance in your body. The loss of too much acidity in your bloodstream may lead to conditions like alkalosis [23].

1.8 Why to choose alkaline water?

People prefer alkaline water since it raises the pH of tap water, neutralizing the body's acidity. Regular clean water often has a pH level of seven, while alkaline water typically measures at 8 or 9 on the pH scale of 0 to 14. In health food and specialized stores, it is offered by the bottle, and businesses can purchase commercial water ionizers to meet their needs. Many people who prefer drinking alkaline water benefit from its immune-system-boosting and detoxifying properties. Although a more thorough scientific investigation is required to support these assertions, maintaining hydration is beneficial to one's health.

Additionally, balancing the body's acidity, which is frequently brought on by environmental toxins and an unbalanced diet, helps to reduce stress on the internal organs, which work hard to remove an acid buildup. Despite its advantages, the key differentiator is the pH level shift in the water. It is crucial to remember that just because water is alkaline or ionized does not mean it has been purified. This might be a crucial consideration when weighing the costs of alkaline water against distilled water. The majority may still want purified water, even though some may enjoy the option.

2. CONCLUSION:

Alkaline drinking water is considered safe. Currently, no evidence demonstrates negative side effects; however, the body's natural acidity levels may be overly neutralized by excessive use of alkaline water, which may eliminate the probiotic "good bacteria" that are necessary. Probiotics are the beneficial bacteria that the body needs to defend itself against diseases and harmful bacteria. Although drinking alkaline water may seem like the finest thing ever, always see a doctor before making the move.

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