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Types and Safety of Mineral Water



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ABSTRACT

The types of mineral water and their safety are discussed in this study. The term mineral water is a misnomer as it is often considered to be drinking water containing a large number of minerals; however, in reality, it refers to drinking water packed in glass bottles or polyethylene terephthalate bottles, and the concentration of minerals is not necessarily related. Not just natural groundwater or groundwater that has undergone treatment, such as filtration, but also groundwater that has been mixed with a variety of other waters is included. Water that has been processed, such as distilled water, is similar to groundwater. Mineral water is used in preparing food in Japan and is treated independently from tap water.

INTRODUCTION

Many indigenous and imported mineral waters are available in Japan as drinking water. Mineral water usage has risen and has become indispensable in modern Japan¹. People's distrust of tap water, growing consciousness about health, and media advertising have led to the growth of the mineral water business. Malodors originating from chlorine compounds and carcinogens, such as trihalomethanes formed in tap water, have made home water filters, boiling treatment, and increasing use of mineral water common¹. With the rapid growth of mineral water consumption, there is concern that its safety and standards may be overlooked by the general public, the quality of drinking water in general, and mineral water, in particular, must be clarified so that consumers have a clear understanding of drinking water.

Types of mineral water and inspection procedures have been discussed in this study. We have explained how safety is guaranteed and offered our ideas while comparing these to tap water.

Definition and type of mineral water

The Food Sanitation Law, established by the Ministry of Health, Labor and Welfare, and the regulation of mineral water (Guidelines for quality labeling of bottled water), established by the Ministry of Agriculture, Forestry, and Fisheries¹, are the current regulations and notifications that govern, what is commonly referred to as mineral water in Japan; however, these guidelines are not legally binding. Mineral water can be interpreted as being different from tap water and can be classified as a soft drink within the food category². The amount of minerals is independent of the classification. Mineral water, as defined by this guideline, is “groundwater, etc., in which drinking water is packed in a container”. It is classified into four types: natural water, natural mineral water, mineral water, and bottled water, depending on the type of raw water utilized and the treatment process (Table 1). While marketing mineral water, it is mandatory to label its type¹ and to specify the raw water used. The following types are used as raw water: ore water (groundwater drawn by a pump and characterized by dissolved ores); mineral spring water (self-spraying groundwater with water temperature less than 25°C, for dissolved ores, etc.); spring water [naturally springing (self-spraying) groundwater]; hot spring water (self-spraying groundwater with a water temperature of 25°C or higher, characterized by dissolved minerals, etc.); well water (groundwater taken from a well); and underflow water (very shallow

groundwater which percolates beneath the riverbed and creates water veins depending on geology and soil quality)²Mineral water can also be classified based on its hardness, which is the concentration of magnesium and calcium in the water, and the calculation formula varies from country to country. In Japan, because hardness is calculated as the concentration of calcium carbonate, the calculation method of $\text{Ca (mg/L)} \times 2.5 + \text{Mg (mg/L)} \times 4.1$ is widely used; however, these numbers vary depending on the criteria set (≥ 120 mg/L is hard water according to WHO standards, but ≥ 60 mg/L is hard water according to the standards of the Ministry of Health, Labor and Welfare)².

Natural mineral water can be further classified into five types: naturally carbonated natural mineral water; decarbonated natural mineral water; natural mineral water fortified with carbon dioxide at the source; and carbonated natural mineral water. Other than natural mineral water, packaged water is defined as water for human consumption, which may contain naturally occurring or added carbon dioxide, but not sugars, sweets, flavors, or other ingredients. In Japan, all mineral water must be sterilized, but sterilization is not required in Europe³). The number of bacteria contained in the water is strictly restricted, and it is necessary to protect the environment around the water sampling area. Even if the raw water used to make mineral water in Japan has a lot of bacteria, it is feasible to make mineral water by sterilizing it; nevertheless, it is not permitted in Europe.

Inspection of mineral water

There are no water source criteria or environmental conservation standards for mineral water production. As a result, the manufacturer is responsible for ensuring the quality. Thus, even if the quality of raw water is poor, the quality of the mineral water produced is satisfactory. This may also be because it is not necessary to continuously sample water from the same source. Soft drinks in Japan are produced in accordance with the Ministry of Health, Labor and Welfare's "Food Sanitation Law Enforcement Regulations" and "Standards and Criteria for Food and Food Additives"¹. The mineral water production standard states that raw water must comply with the Water Supply Law or the 18 items of mineral water production standards. The Ministry of Health, Labor, and Welfare's current water supply law includes 50 water quality standard items for which standard values are defined by the law and inspection is required, as well as 27 water

quality management target setting items. Water quality management target setting items have not been detected in tap water at concentrations that are used as water quality standards, but they will be necessary for management in the future, such as those that may be detected in tap water.

The international standardization of mineral water was conducted by the CODEX Committee¹, which is an international intergovernmental organization established by the Food and Agriculture Organization (FAO) and World Health Organization (WHO) in 1962 to protect consumer health and ensure fair food trade. Although international standards and the Codex Committee's standards are not legally enforceable, it is in principle mandatory to align local standards with international standards, and domestic legislation has been enacted to align mineral water standards in each country with the CODEX standards. This is useful for standardization regardless of the country and seems to be convenient for the smooth import and export of mineral water. Table 2 lists the standard values for mineral water, tap water manufacturing standards, and CODEX standards. There were some differences depending on the type of water used.

Advantages and disadvantages of mineral water

We have compared the advantages and disadvantages of mineral water with the qualities of tap water and inspection methods⁴ in this article. First, many individuals feel that mineral water tastes better than tap water. This is because tap water is subjected to chlorine treatment, which affects its odor and taste. Hardness has an effect on the taste as well; however, in the case of tap water, the hardness remains constant depending on its source, whereas in the case of mineral water there is an option to choose and purchase. Mineral water is also preferred for cooking, as it does not contain chlorine and thus does not interfere with food's aroma. Thus when mineral water is utilized, the food tastes more delectable as compared to tap water⁴ Another advantage of mineral water is that depending on the type of food, the water used can be either soft or hard. Rice tastes better when cooked in soft water. It also helps with weight loss and skin rejuvenation. On the other hand, hard water provides mineral supplementation and is often used during dieting⁴.

However, there are some disadvantages. Mineral water costs approximately US\$ 1 for a 500 mL bottle, while tap water costs approximately US\$ 0.001 for 500 mL, which is approximately 1000

times costlier⁴. Mineral water is cheap in Western countries but is expensive in Japan as it is not ordinarily consumed, and the amount used is not so large. Therefore, they are often purchased for limited purposes, such as for drinking and cooking. Tap water is better than mineral water for ice production as tap water is sterilized with chlorine; therefore, there is little concern that it will spoil. Because of the presence of germs in the refrigerator, it is better to manufacture ice that can be stored for a long time with tap water (which retains sterilizing power) that has been sanitized to the greatest extent possible⁴. When ice is generated using the refrigerator's automatic ice-making features, minerals in the mineral water can precipitate, causing the refrigerator to malfunction. Additionally, tap water is preferred for gargling as the bactericidal effect of chlorine⁴ destroys the cold-causing microbes, whereas mineral water does not have the same effect due to a lack of bactericidal components.

Mineral water, however, is not something one drinks to get minerals. It is a misnomer; yet, the phrase mineral water can be referred to even if it has a low mineral concentration. The amount of calcium and magnesium in a bottle is commonly listed on the label, but this does not imply that it includes a substantial amount of iron, copper, zinc, or other trace minerals.

Issues in Japan regarding mineral water

There is a strange phenomenon where many people buy tap water because it is bottled and being sold⁵. The Tokyo Metropolitan Waterworks Bureau's "Tokyo Water," the Yokohama City Waterworks Bureau's "Hamakko-Doshi The Water," and the Saitama City Waterworks Bureau's "Saitama Water" (all having a volume of 500 mL with a price of approximately 1 dollar) are selling well. While most tap water is treated and disinfected with chlorine, some bottling is done without chlorine treatment. Recently, the Tokyo Metropolitan Government conducted a study in which subjects were blindfolded and asked to consume and compare tap and mineral water. According to the 2017 results, 39.1% of the respondents felt tap water is better, 41.0% found mineral water to be better, and 19.8% said that both tasted the same (a survey in which about 30,000 people participated)⁵. This pattern repeats itself every year, and if there is no bias, such as brand, it can be concluded that the taste is identical to that of tap water. Chlorination can theoretically alter odor and taste, but the difference is minor and difficult to discern without careful comparison. In other words, tap water was avoided due to the misconception that mineral

water tastes better. Tap water can be used for making sake, according to the Tokyo Metropolitan Government. In general, it is better to dismiss the notion that it is bad because it is tap water⁶.

The amount of mineral water packed in PET bottles has increased in recent years, although ailments linked to the environmental hormone called phthalate ester⁷ have been documented, which is used in PET bottle manufacturing as plasticizers. There are concerns that phthalate ester decreases fertility in both men and women. It is also believed that PET bottles are the primary source of littering plastics; thus, even if mineral water is consumed, it is vital to consider filling containers made of alternative materials⁸.

CONCLUSION

As mentioned earlier, the demand for mineral water in Japan is increasing. According to a report by the Japan Mineral Water Association in 2007, the share of mineral water in the soft drink market increased to 12.7%¹. In a survey of private companies on the Internet in 2020-2021, 17.6% of people said they would buy mineral water and 56.7% said they would drink tap water⁹. In another survey, 65.8% of the people used mineral water, including emergency storage². This is mainly because tap water is not palatable, and also its quality is doubtful. Tap water, however, requires more testing and can be deemed safer, as stated in this research. As a result, while it may be comforting to know that water which is properly bottled and pricey may not necessarily be safe.

Moreover, many people do not understand the classification of mineral water. Bottled water is also classified as mineral water; however, it also includes water that is not produced from groundwater⁶. As far as we recall, mineral water was sometimes sold as distilled water with salt added. Because the categorization must be labeled by law, it is important to select water properly by looking at the labeling rather than assuming it is good to taste as it is a bottled product and you may continue to drink the same water if it suits your taste and health. Given the quality of mineral water, it is good to use different types of water depending on the hardness. If you prefer mineral water merely because it tastes good or is good for your body, you should do so regardless of the label or appearance.

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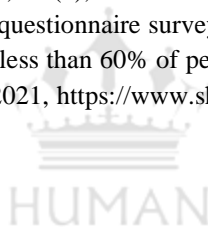


Table 1 Types of mineral water

Name	Detail	Similarity to groundwater
Natural water	Other than precipitation, filtration, and heat sterilization, groundwater obtained from a specific water source is used as raw water and is not treated with physical or chemical treatment, unhomogenized is regarded as natural water.	Almost groundwater
Natural mineral water	Groundwater that has permeated from the earth's surface and in which inorganic salts are dissolved while traveling or remaining underground is used as raw water. This includes effervescent groundwater in which natural carbon dioxide dissolves. Precipitation, filtration, and sterilization should all be done. Unhomogenized. Water that has been labeled as "natural."	Almost groundwater
Mineral water	Natural mineral water is used as raw water, and mineral adjustment, bubbling, and mixing of natural mineral water obtained from diverse water sources, among other things, are done to stabilize the quality. Precipitation, filtration, and heat sterilization should all be done.	Groundwater mixture (not a single groundwater)
Bottled water	Some bottled water contains the same raw water as natural mineral water but is treated differently, while others are tap water that has been sanitized according to the Food Sanitation Law. There is no standardization on the processing method.	In many cases, it cannot be called groundwater

Classification of mineral water distributed in Japan.

Sterilization is essential in Japan, but in some cases, it is not in Europe.

Based on reference 1).

Table 2 Comparison of water quality standards

Type	Mineral water (Ministry of Health, Labor and Welfare)	Tap water	Natural mineral water (CODEX standard)
Items that are in tap water but not in others		36 items such as carbon tetrachloride, 1,4-dioxane, 1,1-dichloroethylene, <i>cis</i> -1,2-dichloroethylene, dichloromethane, tetrachlorethylene, trichloroethylene, benzene, chloroacetic acid, <i>etc.</i>	
Items found only in mineral water	Barium (≤ 1 mg/L), Sulfide		Barium (≤ 0.7 mg/L), Antimony, Nickel
Items that overlap, but have different reference values			
Cadmium:	≤ 0.01 mg/L	≤ 0.01 mg/L	≤ 0.003 mg/L
Mercury:	≤ 0.5 μ g/L	≤ 0.5 μ g/L	≤ 1 μ g/L
Lead:	≤ 0.05 mg/L	≤ 0.01 mg/L	≤ 0.01 mg/L
Arsenic:	≤ 0.05 mg/L	≤ 0.01 mg/L	≤ 0.01 mg/L
Cyanide:	≤ 0.01 mg/L	≤ 0.01 mg/L	≤ 0.07 mg/L
Nitrate nitrogen and Nitrite nitrogen:	≤ 10 mg/L	≤ 10 mg/L	No provision
Fluorine:	≤ 2 mg/L	≤ 0.8 mg/L	Displayed when ≤ 1 mg/L
	≤ 30 mg/L	≤ 1 mg/L	≤ 1 mg/L

Boron:	≤ 5 mg/L	≤ 0.1 mg/L	≤ 5 mg/L
Zinc:	≤ 2 mg/L	≤ 0.05 mg/L	No provision
Manganese:	≤ 12 mg/L	≤ 5 mg/L	≤ 0.5 mg/L
Organic matter:			No provision

Based on reference 1).

