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Differences in Safety of Tap Water, Well Water and Mineral Water Available in Japan



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ABSTRACT

The differences between tap water (clean water), well water, and mineral water available in Japan are described. In general, tap water is inexpensive water supplied to households using water pipes (waterworks) after groundwater is purified using water purification equipment managed by local governments. Along with purification, many types of high-frequency quality inspections are carried out. The use of tap water is not limited to drinking water, but it also includes bathwater. Mineral water is expensive water used for drinking and cooking that is sold in stores. In Japan, it is considered food and unlike tap water, there are few inspection items, and there are instances where manufacturers and distributors voluntarily manage safety. Well, water is free and is groundwater drawn from a well. Because well water use varies with the owner and manager of the well, the types of inspections that must be performed also vary. Of these types of water, tap water is tested most often to ensure a high degree of safety, and it is thought that it can be used with a sense of security when drinking.



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INTRODUCTION:

Just as tap water, well water, and mineral water have different names, their water sampling methods and sources are different. Tap water is purified before it enters the waterworks and can be collected from a faucet at the end of water pipes found in homes for people to use^{1),2)}. Well, water is groundwater that can be drawn from a well. In some cases, well water can be collected from a faucet by installing an electric motor, while in other cases, a pail with a string can be thrown close to the surface of the water or a manual pumping device can be used to collect water. Mineral water is the water that is sold in stores. In recent years, they have been sold in PET bottles. Tap water, well water, and mineral water are clean enough to drink and for domestic use. However, their prices are very different. Tap water costs about US\$ 0.002 per liter, while mineral water often costs about US\$ 2³⁾. Well, water is approximately US\$ 0 (the price of water itself). In addition, the degree of quality and safety assurance, and legal treatment in Japan are also different.

In this paper, we highlight the characteristics of each type of water and describe which water is safest to drink with a sense of security. We will also take a deeper look at well water and discuss its advantages and disadvantages.

Definition of tap water, well water, and mineral water

Rainwater, groundwater, rivers, ponds, and lakes are common sources of tap water. The groundwater mentioned here is the same as the well water described later, but when it undergoes advanced treatments such as filtration and chlorination and enters the waterworks, it is considered tap water⁴⁾. The main difference between well water and tap water is that tap water is properly treated. In addition, the safety of tap water is guaranteed due to water treatment facilities strictly checking the water quality standards (inspection items) included in the Water Supply Act under the management system of the water supply company (Table 1).

Well, water is water that is drawn from water veins underground^{1),2)}. Well, water is often pumped from a water source and used as it is. Unlike tap water, it is not always purified. However, water that seeps from the surface of the earth and passes through the stratum and other layers to settle underground is naturally filtered. Unlike tap water, groundwater is rarely processed. That is, a well corresponds to a facility connected to an underground water vein, and well water has almost the same properties as groundwater. In Japan, wells are often pumped only for small-scale use. Because well owners often use the water themselves rather

than transporting or selling it to others, well water quality is rarely checked by testing. Because well water is rarely processed, it may contain hot springs and natural gas. It is greatly affected by the geology of the underground area, and the ingredients and tastes are different.

Mineral water is often thought of as water rich in minerals, but the concentration of minerals is not particularly important⁵⁾. Mineral water refers to water in glass or PET bottles sold for drinking or cooking. Historically, groundwater was not suitable for drinking in Europe, and drinking water was sold in glass bottles for easy access. Bottled mineral water, which is generally sold in supermarkets and convenience stores, has the same origin as well water. In Japan, it is currently treated as a food and is distinct from the other two types of water. It differs significantly from well water in that its quality is checked before it is bottled. In addition, some mineral waters may be drinking water made by adding a certain amount of minerals to distilled water produced from tap water or tap water itself⁶⁾. It may originate from natural groundwater, but it may also be completely artificially made drinking water.

Advantages and disadvantages of well water

Although not widespread in Japan today, it was common to use well water in the past when waterworks were not widely available. Even with extensive waterworks, some areas and households intentionally use well water. This may be due to several advantages associated with well water. One advantage is that the water temperature remains almost constant throughout the year¹⁾. Tap water is carried through water pipes to the faucets in each household. Water pipes run close to the surface of the earth and are in environments that are easily affected by outside air. Because of the depth of the pipes, tap water feels lukewarm in the summer and cold in the winter. However, because well water is deeper than water pipes, it is not easily affected by outside air and maintains an almost constant temperature throughout the year, and maintains a comfortable coolness. Well water can be used for cooling, storage, food fermentation, or to supplement the air conditioning in a room.

Another advantage of using well water is that it is inexpensive¹⁾. For tap water, charges are incurred according to the amount of water used. Most of these charges are attributable to the cost of treatment to keep the water safe and not the water itself. There are no direct charges associated with well water. Therefore, it is possible to save money by simply using well

water for baths, toilets, and laundry. Well, water is becoming more popular not only with farmers who use a lot of water but also with individuals who want to lower their water bills.

The third advantage of well water is that it can be used in disasters. Japan is a country prone to natural disasters such as earthquakes and typhoons. Every year, natural disasters cause extensive damage and adversely affect daily life and activities. Well, water is useful as public disaster water. By installing a well, measures can be taken to prevent human lives from being affected in case of an emergency. Because it is transported over long distances using water pipes, tap water is inaccessible if the pipes are blocked or damaged due to a disaster. Well, water remains accessible even if the tap water supply is cut off because the water source is nearby and does not pass through water pipes. Modern wells have equipment that can be pumped by electricity, making them less difficult to use in daily life. In the eventuality that the well cannot be pumped electrically, it can be pumped manually, a method sometimes used as a countermeasure in the event of a power outage.

Another advantage of using well water is that there is no unpleasant odor or taste¹⁾. Chlorination can cause tap water to smell. If the water has an odor, it can affect the taste, which is why many people are reluctant to drink tap water. However, well water has not been artificially treated. Therefore, it has no odor or taste and is very easy to drink.

Despite the benefits, there are several drawbacks associated with using well water. Considering the advantages of using well water, it may seem that well water is all-purpose, but in reality, there are many disadvantages. First, there is the initial cost¹⁾. Well, water is free, but adequate preparation is required to ensure it is safe to use. First, the machinery and tools to make the well must be acquired. There is an additional cost to install a hole in the water vein, check the water quality, and install a pumping device. Depending on the depth of the well, installation can cost at least US\$ 4,000 (in Japan). There are also additional costs after the well is built. To continue using the well water, regular water quality testing is required¹⁾. To drink the water from the well, an annual examination is mandatory. This is because drinking untested well water puts you at risk of contracting an infectious disease. Because water quality changes with the condition of the land and the surrounding environment, it might not be possible to maintain sufficient water quality for drinking⁷⁾. In addition, the inspection items are different for daily use and drinking⁸⁾. The cost of using well water as drinking water is approximately US\$ 2,000-3,000, and individuals who own and manage wells must perform the same inspection as tap water. When an electric pump is

installed, electricity costs are also incurred. Therefore, in some cases, it may be cheaper to use tap water than to install a well¹⁾.

Furthermore, as mentioned earlier, well water might not be accessible during a power outage. If you have equipment that can be pumped manually, you may be able to obtain water with some effort, but this can be laborious if the water source is very deep. Even if a well is installed, it is not always possible to use it for its intended purpose. If it contains many bacteria and harmful substances, it cannot be used as domestic water unless it is treated¹⁾. Previous studies have reported cases where nitrate-nitrogen is abundant^{9),10)} or arsenic has been detected^{4),11)} in well water. Drinking these waters can result in death. Well, water containing manganese or iron may discolor laundry during washing¹⁾. Introducing water-containing diatoms to a pond may turn the water brown due to air oxidation¹²⁾. Well, water is often unfiltered and may contain sand and debris.

Differences in inspection methods and safety for each type of water

Table 1 shows the inspection methods for each type of water^{6),13)}. Currently, tap water is tested for 51 items under the Water Supply Act established by the Ministry of Health, Labor, and Welfare. Depending on the method, these inspection items include those that are performed many times a day and items that are performed only once every few months. Inspections are held at least once per year. Of the three types of water described in this paper, tap water is the most frequently inspected, and its safety is relatively guaranteed.

Although not previously mentioned in this paper, there are several types of mineral water⁶⁾. Natural water is groundwater that is collected from a specific water source as raw water and is not subjected to physical or chemical treatment other than precipitation, filtration, or heat sterilization. Natural mineral water is groundwater containing inorganic salts from the stratum that dissolve as water makes its way underground from the ground surface. This includes groundwater in which natural carbon dioxide is dissolved and effervescent. Mineral water uses natural mineral water as raw material and, to stabilize the quality, natural mineral water collected from multiple water sources are mixed and aerated and mineral adjustment is performed. Some bottles contain water that has the same raw water as natural mineral water but has a different treatment method, while others contain tap water that has been sterilized by the Food Sanitation Law. What is commonly referred to as mineral water is natural water, natural mineral water, or mineral water, but there are also differences between them. It also

includes water that, by definition, is not normally considered mineral water, such as bottled water. In Japan, mineral water is treated as food, and 18 items are tested by the manufacturing standards for mineral water set by the Ministry of Health, Labor, and Welfare⁶). Many of these inspection items overlap with tap water, but they are fewer than tap water, and the inspection frequency is low. This can be confirmed by the fact that the inspection value is printed and displayed on the container of the commercial product, and the value does not change for a while. Therefore, we believe that mineral water is not necessarily safer than tap water. The difference in the inspection contents is because there is a possibility that harmful chlorine compounds, which are by-products, may be generated in tap water due to chlorine disinfection. Since sewage can be reused as raw water for tap water after being used by humans, it is necessary to check for harmful substances that are expected to be introduced during use. Since mineral water is treated as a food, it should be taken treated at the time of manufacture so that drinking does not cause illness. Mineral water is about 1000 times as expensive as tap water, and consumers can choose to buy it (contrary to not being able to choose tap water depending on their address). Because the amount used is less than that of tap water, the water source can be limited. It seems that mineral water is manufactured to make it more appealing than other types of water (appearance, taste). In addition to the necessary safety inspections, other properties, such as appearance, are also tested. Safety should also be considered. However, since this seems arbitrary on the part of the manufacturer, it depends on whether the manufacturer can be trusted, and special attention may be required for imported products. Safety cannot be guaranteed consistently for all products.

As indicated in the previous section, it is up to the user and manager to test the well water depending on the intended use. If used for drinking, it is necessary to consider the frequency of costly voluntary inspections. However, it is not known how stable the quantity and quality of water are. Since testing at the same frequency as tap water is expensive and difficult in practice, it is rarely carried out and safety may be ignored to keep costs low. However, in Japan, it is mainly used as miscellaneous water (intermediate water) rather than drinking water.

Previous research information

According to a survey in previous research, mineral water accounts for 12.7% of soft drinks when only drinking is considered⁶). A poll was conducted by the Ministry of Internal Affairs

and Communications in 2008¹⁴). The poll found that 37.5% of people drank tap water, 29.6% of responders purchased and drank mineral water, while the others drank tap water after passing it through a water purifier or boiling it to purify it. The reasons for this difference are the awareness of environmental issues, considering one's own health, a feeling of anxiety about the quality of tap water, and considering the stable supply of tap water. It is thought to be influenced by the habits of the childhood home¹⁴). In another report, a survey of private companies on the Internet in 2020-2021 found that 17.6% of people bought mineral water and 56.7% drank tap water directly from the faucet¹⁵). The reason for drinking mineral water is that it is often delicious (62.6%), while tap water is not (38.6%); thus, it seems that mineral water may be selected as a result of the taste. Other reasons for choosing mineral water were anxiety about tap water (37.5%), an abundance of minerals (30.6%), and safety (24.7%). However, these are not always correct, as mentioned above. The figures differ depending on the survey time and method, but it is a fact that mineral water is used in large quantities, and it is thought that the use of tap water is decreasing accordingly.

However, there are reports that mineral water in PET bottles is not safe^{3),16}). It is known that environmental hormones called phthalates derived from containers are detected in the water contained in PET bottles¹⁶). This additive is used to make PET bottles easier to process. Phthalates have been reported to have adverse health effects, such as reduced sperm counts in men and reduced pregnancy rates in women. In addition, antimony, a carcinogen, has been detected *via* leaching³). Furthermore, unlike Japan, mineral water produced in the United States may be filled with tap water without any inspections.

CONCLUSION:

In this paper, we highlight the differences between tap water, well water, and mineral water. While these waters are drinkable, they must be inspected in advance. This also helps the user feel secure. Groundwater may be included in all three types of water; however, the water quality is greatly affected by the type of ground and the number of minerals in the location where it was sourced. If it is in the same place, tap water can be stably supplied in large quantities, and the quality will be constant. The quality and quantity of well water may change over time, so it is necessary for the user to properly inspect and control the quality. Mineral water does not contain chlorine and is easy to drink, but long-term consumption may have adverse health effects due to substances originating from containers such as PET bottles. In addition, caution is required because sufficient inspection has not been conducted.

Tap water may not be delicious in Japan, but many people take it for granted that they can drink it. However, there are only 15 countries (Germany, Austria, Switzerland, Croatia, Slovenia, Finland, Sweden, Iceland, Ireland, Australia, New Zealand, South Africa, Mozambique, United Arab Emirates, and Japan) worldwide where you can drink tap water¹⁷⁾. Tap water in Japan is very cheap because the raw water is relatively clean and does not require much treatment for tap water production, and it is readily available⁸⁾. However, some people take this for granted and prefer not to drink tap water. Drinking tap water is natural, but it may be necessary to promote its use by making information, such as inspection items, widely available. In addition, a decrease in the use of tap water makes it difficult to maintain infrastructure such as water pipes and water purification facilities. If the decline in usage accelerates, prices will increase, and it will be difficult to use tap water for purposes other than drinking. Mineral water is too expensive to use except for drinking. Well, water has the potential to be used instead of tap water if its properties are known to some extent. Because groundwater is not evenly distributed everywhere, the number of people who can use it is limited. It is reasonable to believe that fully understanding the characteristics of each type of water and considering its use will lead to cost reduction and will not harm health. It is expected that the number of cases in which tap water is manufactured and managed by private companies rather than by local governments will increase in the future, and it is necessary to pay close attention to whether safety is properly protected.

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Table No. 1 Differences in water quality standards between tap water and mineral water

Type	Tap water	Mineral water
Number of inspections	51	18
Tested for tap water but not mineral water	Carbon tetrachloride, 1,4-Dioxane, 1,1-Dichloroethylene, <i>cis</i> -1,2-Dichloroethylene, Dichloromethane, Tetrachlorethylene, Trichloroethylene, Benzene, Chloroacetic acid, Chloroform, Dichloroacetic acid, Dibromochloromethane, Bromic acid, Total trihalomethane, Trichloroacetic acid, Bromodichloromethane, Bromoform, Formaldehyde, Aluminum, Iron, Sodium, Chloride ion, Calcium / magnesium, <i>etc.</i> , Evaporation residue, Anionic surfactant, Geosmine, 2-Methylisobornole, Nonionic surfactant, Phenols, pH, Taste, Odor, Chromaticity, Turbidity	
Tested for mineral water but not tap water		Barium, Sulfide, Potassium permanganate consumption
Items used for both but have different standard values		
Lead	0.01 mg/L	0.05 mg/L
Arsenic	0.01 mg/L	0.05 mg/L
Fluorine	0.8 mg/L	2 mg/L
Boron	1 mg/L	30 mg/L
Zinc	0.1 mg/L	5 mg/L
Manganese	0.05 mg/L	2 mg/L
Organic matter	5 mg/L	12 mg/L

Based on references 6) and 13).