MINERAL WATER VERSUS DEMINERALIZED WATER: A COMPARATIVE REVIEW BASED ON SCIENTIFIC EVIDENCE OF COMPOSITION AND HEALTH BENEFITS

Pardomuan Robinson Sihombing
BPS-Statistics Indonesia

Abstract

The consumption of bottled drinking water (BDW) shows a significant upward trend globally, but is accompanied by public confusion regarding the fundamental differences between the various types of products available, especially mineral water and demineralized water. This study aims to conduct a comparative analysis based on scientific evidence of the two types of water. Using a systematic literature review of indexed primary research articles, this study examines the differences in definition, production process, chemical composition, and implications for human health. The analysis shows that mineral water, with its natural mineral content, calcium, and magnesium, significantly benefits bone and cardiovascular health. Conversely, long-term consumption of demineralized water is not recommended for the general population because it risks causing electrolyte imbalances and leaching essential nutrients from food during cooking. The optimal choice of water type is proven to be highly dependent on individual physiological contexts; mineral water is ideal for daily hydration and athlete recovery, while demineralized water has a crucial role in specific medical applications such as hemodialysis and has the potential to reduce the risk of kidney stones in susceptible individuals. It is concluded that mineral water is a physiologically superior choice for daily consumption by the general public. Better public education is needed to improve consumer understanding in choosing drinking water that suits their health needs.

Keywords: *demineralized water; health; mineral water*

*email korespondensi: robinson@bps.go.id

INTRODUCTION

Over the past few decades, the increased consumption of bottled drinking water (BDW) has been a consistent global trend (Doria, 2006) (Hu et al., 2011). Paradoxically, this trend also occurs in countries with excellent tap water quality, indicating that consumer choices are driven by the need for safe drinking water and psychological and perceptual factors (Doria, 2006); (Yavorova et al., 2025). Amidst the abundance of choices in the market, there is a significant knowledge gap among the public regarding the essential differences between types of bottled water, particularly between mineral water and demineralized water (also known as pure water or RO water). This confusion is often exacerbated by marketing claims that emphasize the "purity" as the sole measure of quality, without explaining the physiological implications of lacking minerals.

Consumer choices are often based on subjective perceptions of organoleptic quality (taste and smell) and concerns about the health risks of tap water, rather than on a scientific understanding of the chemical composition of water and its impact on the body (Doria, 2006) (Sajjadi et al., 2016). This data creates a disconnect between consumer behavior and scientific evidence. For example, consumers may choose water processed with advanced technology because it is considered "safer" and "purer," without realizing that it removes essential minerals the body needs.

Previous studies have examined this topic from various perspectives. Many epidemiological studies have identified the benefits of mineral-rich water (hard water) in reducing the risk of cardiovascular disease (Momeni et al., 2014) (Yang, 1998)(Yang et al., 2006) (Monarca et al., 2006). On the other hand, several studies have highlighted the potential health risks of long-term consumption of demineralized water, including potential electrolyte imbalances and the loss of nutrients from cooked foods (Haring & Delft, 1981) (Choi et al., 2021). However, there is still a research gap in the form of a lack of comprehensive reviews that integrate this various evidence to present it directly to the public in an easily understandable format. This article aims to fill this gap by synthesizing the existing scientific evidence to clearly compare mineral and demineralized water, from the production process to the health implications in various contexts.

METOHD

This study uses a *literature review* design to synthesize and analyze existing research comprehensively. This methodology was chosen for its ability to identify trends, aggregate findings, and build a complete understanding of a topic based on the existing literature corpus(Templier & Paré, 2015). The review procedure adopted a systematic six-step framework as outlined by Templier and Paré (2015), which included: (1) formulating research questions (comparing the characteristics, benefits, and risks of mineral water vs. demineralized water);

(2) searching for relevant literature; (3) screening articles based on inclusion criteria; (4) assessing the quality of primary studies; (5) extracting data; and (6) analyzing and synthesizing data.

The literature search was conducted in leading international scientific databases, including Scopus, PubMed, Science Direct, and EBSCO, to ensure broad coverage and high. Keywords used in the search included, but were not limited to, "mineral water," "demineralized water," "distilled water," "reverse osmosis water," "water hardness," "cardiovascular health," "bone health," "electrolyte balance," "cooking nutrient loss," and "hemodialysis water." Strict inclusion criteria were applied to maintain scientific validity. Only primary research articles (clinical studies, epidemiological studies, experimental studies) published in Scopus or Sinta (rankings 1 and 2) indexed journals were included in the primary analysis. Review articles (including *Systematic Literature Reviews)*, news reports, blogs, and other non-peer-reviewed sources were excluded as primary evidence per the study's objective to present a data-based analysis of original research.

RESULT

The fundamental differences between mineral and demineralized water lie in their sources, composition, and production processes. Natural mineral water is defined as water originating from underground water sources that are protected from contamination, have natural purity, and are characterized by stable amounts and compositions of minerals and trace elements (FAO, 2019). Its unique composition reflects the geological conditions of the rock layers it passes through. The production process is minimal, generally involving only filtration to ensure microbiological safety without altering the original mineral composition (Suryaman & Rohmayanti, 2025);(Dewi & Fitrilia, 2024). In Indonesia, several brands that fall into this category are AQUA, Le Minerale, and VIT.

In contrast, demineralized water is water from various sources (including groundwater or surface water) that has undergone a series of industrial processes to remove almost all minerals and dissolved salts (Suryani et al., 2022); (Chairunissa et al., 2021). This process produces water with a very high level of purity H_2O. A commonly used technology is Reverse Osmosis (RO), which uses pressure to force water through a semipermeable membrane that retains minerals and contaminants (Suryani et al., 2022). Other industrial processes, such as distillation and deionization, are also used for the same purpose. Examples of demineralized water brands available in the Indonesian market include Cleo, Oxy, and Akeo. A comparison of their characteristics is summarized in Table 1.

Table 1. Comparison of Mineral Water and Demineralized Water Characteristics

Characteristics	Mineral Water	Demineralized Water	Key Reference
Source	Protected natural underground water sources	Various sources (groundwater, surface water) that have been processed	(FAO, 2019); (Suryani et al., 2022).
Production Process	Minimal (e.g., filtration)	Advanced (Reverse Osmosis, Distillation, Deionization)	(Suryani et al., 2022)
Mineral Content	Contains dissolved minerals (TDS >50 mg/L) such as Calcium (Ca), Magnesium (Mg), Sodium (Na)	Very little or no minerals (TDS <10 mg/L)	(FAO, 2019); (Suryani et al., 2022)
Taste	Varies, characteristic according to mineral profile	Bland or neutral	(Doria, 2006)
General Use	Daily consumption	Industrial, medical, and laboratory applications require pure water	(Doria, 2006); (Layman-Amato et al., 2013)

The health benefits of mineral water come from its function as a hydrator and its mineral content, which has high bioavailability. This result means that minerals such as magnesium in water are present in ionic form, which is easily absorbed by the body (Sabatier et al., 2003). Regarding bone health, animal studies have shown that bicarbonate-rich mineral water can improve bone microstructure and counteract the effects of metabolic acidosis, a condition that can trigger calcium release from bones (Tan et al., 2022) (Wasserfurth et al., 2019).

However, mineral water's most notable benefit is cardiovascular health. Various epidemiological studies around the world have consistently found an inverse relationship between water hardness (calcium and magnesium content) and mortality from cardiovascular disease (CVD) (Momeni et al., 2014) (Yang, 1998)(Yang et al., 2006) (Monarca et al., 2006). The higher the mineral content in a population's drinking water, the lower the risk of CVD mortality. A more in-depth analysis of this data reveals an important nuance: although water hardness is determined by calcium and magnesium, strong scientific evidence suggests that

Magnesium is the primary protective agent. The chain of evidence can be outlined as follows: first, extensive case-control studies identified a strong negative correlation between magnesium intake from drinking water and the risk of death from cerebrovascular disease and hypertension (Yang, 1998)(Yang et al., 2006)(Monarca et al., 2006). Second, when researchers statistically analyzed the data and controlled (adjusted) for magnesium levels, the protective relationship between calcium and these diseases often became statistically insignificant (Yang, 1998)(Yang et al., 2006). This result indicates that the protective effects observed previously were driven more by magnesium. Thus, it is not just total dissolved solids (TDS) or "hardness" in general that is important, but rather the specific mineral composition, with magnesium playing a central role in cardiovascular protection.

Unlike mineral water, long-term consumption of demineralized water as the primary source of hydration can pose several health risks. The most immediate risk is the potential for electrolyte imbalance. If electrolyte loss through sweat is only replaced with large amounts of demineralized water, plasma sodium concentration can decrease significantly, leading to hyponatremia (Choi et al., 2021).

However, the most significant and often overlooked risk is the leaching of nutrients from food. This data creates what can be described as a "double jeopardy" effect. The first hazard is passive, namely the failure of demineralized water to provide essential minerals. The second hazard, which is more active and destructive, is its ability to draw minerals out of food during cooking. Based on the principle of osmosis, water with a very low concentration of dissolved substances (such as demineralized water) acts as an aggressive solvent. When used to boil vegetables, meat, or cereals, this water will draw important minerals from within the food into the cooking water, often discarded (Haring & Delft, 1981). Studies have shown that this process can cause substantial loss of essential minerals. Conversely, cooking with hard water (rich in minerals) can increase food's calcium content (Haring & Delft, 1981). Thus, individuals who rely on demineralized water not only lose a source of minerals from their drinking water but also actively reduce the nutritional content of their food, potentially exacerbating marginal mineral deficiencies in a population. These risks are summarized in Table 2.

Table 2. Potential Health Risks from Long-Term Consumption of Demineralized Water

Risk	Physiological Mechanism	Key References
Increased Risk of Electrolyte Imbalance	Consuming large amounts of mineral-free water after sweating can lower plasma sodium concentration.	(Choi et al., 2021)
Nutrient Leaching from Food	The strong solvent properties of water during cooking draw essential minerals from vegetables and meat into the cooking water.	(Haring & Delft, 1981)

DISCUSSION

This comparative analysis reveals that no single type of water is universally "best." The optimal choice depends heavily on an individual's physiological condition and needs. This result is most evident when comparing the needs of athletes, individuals prone to kidney stones, and patients with chronic kidney disease, which illustrates the duality of minerals: as essential nutrients on one hand, and as harmful contaminants on the other.

For athletes, intense physical activity causes significant loss of fluids and electrolytes (especially sodium, potassium, and magnesium) through sweat. Rehydration with mineral-rich water can help replace these lost electrolytes, accelerating the recovery of aerobic capacity and muscle strength more effectively than plain water or demineralized water (AL-Qurashi et al., 2022); (Stasiule et al., 2014). Consuming demineralized water alone in this situation increases the risk of dilutional hyponatremia, where sodium levels in the blood dilute (Choi et al., 2021). In this context, minerals in drinking water are beneficial therapeutic components.

High fluid intake is the most important preventive strategy to reduce mineral supersaturation in urine for individuals with a history of or susceptibility to kidney stone formation, especially calcium oxalate stones. In this context, the type of water consumed can be a relevant factor. Some studies suggest that consuming hard water (high in calcium) may increase urinary calcium excretion in individuals prone to stone formation, which theoretically could increase the risk. Therefore, demineralized water can help reduce the risk of kidney stone formation because it does not contain minerals that can accumulate in the kidneys. By not contributing additional mineral load, demineralized water helps maximize the urine dilution effect of high fluid intake without increasing calcium concentration.

Conversely, for patients with end-stage chronic kidney disease (CKD) or those undergoing hemodialysis, the situation is reversed 180 degrees. Their kidneys have lost the ability to filter and remove excess fluid and minerals from the blood (Kim & Jung, 2020). Therefore, demineralized water is a crucial choice for individuals with certain medical conditions, such as kidney failure, or those following a diet with stringent mineral intake control. During a hemodialysis session, the patient's blood is exposed to hundreds of liters of water used to make dialysate. This water must be of a very high purity level and, therefore, must be demineralized water produced through RO. The standards set by the

Association for the Advancement of Medical Instrumentation (AAMI) is very strict, requiring the almost total removal of all minerals and contaminants to prevent the transfer of these substances into the patient's bloodstream, which can be toxic(Layman-Amato et al., 2013). In this critical clinical context, the same minerals beneficial to athletes are considered harmful contaminants.

CONCLUSION

Based on a comprehensive synthesis of scientific evidence, it can be concluded that mineral and demineralized water have very different characteristics and health implications. For the general healthy population, consuming mineral water as a daily hydration source is superior. Its natural mineral content, particularly magnesium and calcium, provides measurable benefits for cardiovascular and bone health, with high bioavailability.

Conversely, while safe for occasional consumption, demineralized water is not recommended as a primary source of drinking water for the general public in the long term. The risks are twofold: not only does it fail to provide essential minerals, but it also has the potential to leach important nutrients from food during cooking. Its primary value lies in concrete industrial and medical applications, such as hemodialysis processes, where absolute purity is a non-negotiable requirement. Additionally, demineralized water may be a wiser choice for individuals prone to calcium-based kidney stone formation than hard water.

Based on these findings, several recommendations can be formulated:

1. For Consumers: It is recommended that they choose mineral water for daily consumption. Consumers must be educated to pay attention to the mineral composition on the label, not just the "purity" claims." In addition, it is recommended to use mineral-containing water when cooking, especially for boiling vegetables, to minimize nutrient loss.
2. For Public Health Practitioners: There is a need to develop more nuanced public education campaigns on hydration, which clearly distinguish between types of drinking water and highlight the importance of mineral intake from water. Regulators can also encourage manufacturers to provide more informative labeling regarding the Total Dissolved Solids (TDS) content and major minerals in bottled water products.
3. For Future Research: More long-term *randomized controlled trials* are needed to confirm the causal relationship between magnesium-rich water consumption and reduced CVD mortality. In addition, further quantitative research is needed to assess the real impact of using demineralized water for cooking on the overall nutritional status of the population.

REFERENCES

AL-Qurashi, T. M., Aljaloud, K. S., Aldayel, A., Alsharif, Y. R., Alaqil, A. I., & Alshuwaier, G. O. (2022). Effect of Rehydration with Mineral Water on Cardiorespiratory Fitness Following Exercise-Induced Dehydration in Athletes. *Journal of Men's Health*, *18*(10). https://doi.org/10.31083/j.jomh1810206

Chairunissa, A. A., Prasetyo, D., & Mulyadi, E. (2021). Pembuatan Air Demineral Menggunakan Membran Reverse Osmosis (Ro) Dengan Pengaruh Debit Dan Tekanan. *Jurnal Teknik Kimia*, *15*(2), 66–72. https://doi.org/10.33005/jurnal_tekkim.v15i2.2544

Choi, D. H., Cho, J. Y., Koo, J. H., & Kim, T. K. (2021). Effects of electrolyte supplements on body water homeostasis and exercise performance during exhaustive exercise. *Applied Sciences (Switzerland)*, *11*(19). https://doi.org/10.3390/app11199093

Dewi, R. A., & Fitrilia, T. (2024). Proses Produksi Air Minum dalam Kemasan (AMDK). *Karimah Tauhid*, *3*(9), 10752–10760. https://doi.org/10.30997/karimahtauhid.v3i9.15462

Doria, M. F. (2006). Bottled water versus tap water: Understanding consumer's preferences. *Journal of Water and Health*, *4*(2), 271–276. https://doi.org/10.2166/wh.2006.008

FAO. (2019). *Codex Standard for Mineral Waters*.

Haring, B. S. A., & Delft, W. Van. (1981). Changes in the mineral composition of food as a result of cooking in "hard" and "soft" waters. *Archives of Environmental Health*, *36*(1), 33–35. https://doi.org/10.1080/00039896.1981.10667603

Hu, Z., Morton, L. W., & Mahler, R. L. (2011). Bottled water: United States consumers and their perceptions of water quality. *International Journal of Environmental Research and Public Health*, *8*(2), 565–578. https://doi.org/10.3390/ijerph8020565

Kim, S. M., & Jung, J. Y. (2020). Nutritional management in patients with chronic kidney disease. *Korean Journal* *of Internal Medicine*, *35*(6), 1279–1290. https://doi.org/10.3904/kjim.2020.408

Layman-Amato, R., Curtis, J., & Payne, G. M. (2013). Water treatment for hemodialysis: A 2005 update. *Contributions to Nephrology*, *40*(5), 404–465. https://doi.org/10.1159/000085422

Momeni, M., Gharedaghi, Z., Amin, M. M., Poursafa, P., & Mansourian, M. (2014). Does water hardness have preventive effect on cardiovascular disease? *International Journal of Preventive Medicine*, *5*(2), 159–163.

Monarca, S., Donato, F., Zerbini, I., Calderon, R. L., & Craun, G. F. (2006). Review of epidemiological studies on drinking water hardness and cardiovascular diseases. *European Journal of Cardiovascular Prevention and Rehabilitation*, *13*(4), 495–506. https://doi.org/10.1097/01.hjr.0000214608.99113.5c

Sabatier, M., Arnaud, M. J., & Turnlund, J. R. (2003). Magnesium absorption from mineral water. *European Journal of Clinical Nutrition*, *57*(6), 801–802. https://doi.org/10.1038/sj.ejcn.1601750

Sajjadi, S. A., Alipour, V., Matlabi, M., & Biglari4, H. (2016). Consumer Perception and Preference of Drinking Water Sources Seyed. *Electronic Physician*, *8*(11), 3228–3233.

Stasiule, L., Capkauskiene, S., Vizbaraite, D., & Stasiulis, A. (2014). Deep mineral water accelerates recovery after dehydrating aerobic exercise: A randomized, double-blind, placebo-controlled crossover study. *Journal of the International Society of Sports Nutrition*, *11*(1), 1–7. https://doi.org/10.1186/1550-2783-11-34

Suryaman, F. D., & Rohmayanti, T. (2025). Proses Produksi Air Minum dalam Kemasan 220 mL di PT. XY, Sukabumi. *Karimah Tauhid*, *4*(5), 2783–2791. https://doi.org/10.30997/karimahtauhid.v4i5.18868

Suryani, F., Madagaskar, M., & Moulita, R. A. N. (2022). Analisis Pengaruh Waktu Dan Tekanan Terhadap Demineralisasi Air Buangan Ac Dengan Metode Reverse Osmosis. *Jurnal Redoks*, *7*(1), 1–9. https://doi.org/10.31851/redoks.v7i1.7924

Tan, Y., Xu, A., Qiu, Z., Wang, L., Wang, J., Luo, J., Zeng, H., Jin, H., Wang, Y., Xue, J., Huang, Y., & Shu, W. (2022). Drinking Natural Mineral Water Maintains Bone Health in Young Rats With Metabolic Acidosis. *Frontiers in Nutrition*, *9*(March), 1–11. https://doi.org/10.3389/fnut.2022.813202

Templier, M., & Paré, G. (2015). A Framework for Guiding and Evaluating Literature Reviews Mathieu. *Communications of the Association for Information Systems*, *37*(1), 91–106.

Wasserfurth, P., Schneider, I., Ströhle, A., Nebl, J., Bitterlich, N., & Hahn, A. (2019). Effects of mineral waters on acid–base status in healthy adults: Results of a randomized trial. *Food and Nutrition Research*, *63*(October), 1–11. https://doi.org/10.29219/fnr.v63.3515

Yang, C. Y. (1998). Calcium and magnesium in drinking water and risk of death from cerebrovascular disease. *Stroke*, *29*(2), 411–414. https://doi.org/10.1161/01.STR.29.2.411

Yang, C. Y., Chang, C. C., Tsai, S. S., & Chiu, H. F. (2006). Calcium and magnesium in drinking water and risk of death from acute myocardial infarction in Taiwan. *Environmental Research*, *101*(3), 407–411. https://doi.org/10.1016/j.envres.2005.12.019

Yavorova, P., Harizanova, S., & Toseva, E. (2025). BOTTLED OR TAP WATER – THE CONSUMER ' S CHOICE ? *MEDIS - Medical Science and Research*, *4*(3), 31–36. https://doi.org/10.35120/medisij0403031y