Mineral water or tap water? An endless debate
O. De Giglio*, A. Quaranta*, G. Lovero*, G. Caggiano*, M.T. Montagna*

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Abstract
The consumption of mineral water has been increasing because of the frequent and unjustified reports of the water supply contamination. However some authors have shown that bottled waters are not always better than tap water. Mineral waters are more palatable for organoleptic characteristic because, being pure at source, they do not undergo disinfection treatments and are sometimes enriched with CO₂. In fact, they are characterized by their microbial facies subject to changes during the production cycle which can contribute to their contamination.
It is necessary to provide people with the tools necessary to operate a critical choice of the type of water to be consumed not exclusively for their organoleptic characteristics or marketing strategies.

Introduction
The consumption of mineral water has increased over the previous decades because of frequent and sometimes unjustified reports of water supply network contamination.
In Italy, although fees are the lowest in the market, many individuals are still reluctant to drink tap water. In 2011, 30% of Italian families preferred to drink mineral water, spending about 20 €/month — slightly less than the average expense incurred for domestic tap water service. Mineral water consumption was highest in Sicily (60.1%), Sardinia (53.4%) and Calabria (47.7%) (1).
Mineral waters, while classified as bacteriologically pure, are actually characterized by a microbial facies that may be subject to quantitative and qualitative changes, mainly because of the phases of the production cycle: the hygiene of the premises; the maintenance of production, distribution and packaging systems; methods of ventilation in bottling establishments; cleaning of filters and bottle washer machines; and transport systems. The manufacturing staff also plays an important role, including the number of workers, their level of preparation, type of clothing, health status and operational behaviour.

Health promotion requests the development and dissemination of appropriate knowledge tools about water quality. Information on intervention methods that guarantee the water quality must be properly disseminated through bidirectional communication. In the absence of comprehensive and clear information, individuals will continue to have inappropriate perceptions of water...
reliability and consequently will decide what water to consume on the only basis of taste. To increase awareness and stimulate critical reflection on the value of water, competent organizations should develop educational materials to provide people with the tools necessary to exercise their right of choice.

**Bottled water**

The current legislation (2-4) has divided the packaged water market into three categories: tap water, spring water and natural mineral water.

**Tap water**

Tap water is commonly called ‘drinking water’. It comes from springs, wells, rivers, lakes and reservoirs and is usually subject to cleaning treatment. It is distributed through the public water supply network, or in tanks, bottles and other containers. Describing the analytic composition on the label of the containers is not required; tap water cannot boast therapeutic properties as mineral water can. In Italy, tap waters must satisfy the requirements of the Legislative Decree No 31/2001 (2) (transposition of Directive 98/83/EC) and subsequent amendments and additions (3).


The WSP defines the statutory management of drinking water, a part of which is already implemented in the system of production, aiming not only to reduce the possibility of abstracted water contamination but also to prevent contamination during storage and distribution of water (7). Furthermore, the WSP highlights the need to establish close cooperation between the health authorities responsible for checks and surveillance and those working in water services, including the need to provide correct and transparent information to the public. For this purpose, the WSP strengthens the criteria and procedures for managing existing regulations that protect food hygiene standards [ISO 9001: 2001 and Hazard Analysis and Critical Control Points (HAACP)]. The link between food and drinking water is very close: the food chain consumes about 90% of drinking water (8).

In Italy, the WSP model is currently being tested. Puglia has included the WSP in the Regional Regulation of January 9, 2014, which governs the release of the judgment of suitability assuring adequate surveillance and control of water intended for human consumption (9).

The chemical and physical characteristics of water vary according to its origin (surface water, groundwater, or brackish water). 85.6% of the water used at the national level comes from groundwater (source or well), 14.3% from surface water (river, natural lake, or reservoir), and 0.1% from desalted sea water or brackish water (1). Groundwater is the greatest and most precious fresh water resource, and it is less vulnerable to acts of anthropogenic pollution. Surface waters, in contrast, incur high costs for suitable purification treatments, and the use of chemicals can change the characteristics of the water, which does not apply for treatments with ultraviolet rays or ozone. Today, because of the limited availability of water resources, Italy also resorts to desalination of sea water, but this involves complex and expensive procedures (1).

When water is distributed through an artificial network, its quality can deteriorate along the distribution path; causes of deterioration include old pipes, corrosion, and leaks. Therefore, it is essential that there always be residual disinfectant.
Moreover, derogations are granted to the parameter values of some undesirable and toxic elements including arsenic, chlorite, and trihalomethanes, provided their concentrations pose no potential danger to human health (2). In Italy, since 2005 it has been mandatory to publish a report on the composition of water intended for human consumption every three years (10) so it is possible to get detailed information on the quality of water in one’s own area.

**Spring water**

Spring water is exclusively of underground origin. It can come from a natural source or from wells. The chemical composition and temperature should not fluctuate significantly over time. Spring water is packaged at the source because it can only be transported through pipes to supply the manufacturing plant. Geological, hydrogeological and microbiological parameters must comply with Decree No 176/2011 (4) for mineral water, while the values of the organoleptic, physical, chemical and physicochemical (dry residue: DR) parameters must be within the limits set for drinking water (2).

Spring water cannot be disinfected; it can only be subject to specific treatments also granted for mineral water, including the removal of arsenic, the separation of unstable compounds of iron, manganese and sulfur, the total or partial elimination of carbon dioxide with exclusively physical methods, and the possibility of introducing successively carbon dioxide (4). The absence of disinfection treatment makes these waters very similar to mineral water. However, unlike mineral water, spring water cannot be carbonated at the origin and it is not necessary to print the chemical composition or pharmacological, physiological and clinical assessments on the labels. Therefore, it is not possible to attribute properties favorable to health to spring water.

**Natural mineral water**

Natural mineral water, governed by Legislative Decree No. 176/2011 (4) (implementing Directive 2009/54/EC) having originated from an aquifer or underground reservoir, comes from one or more natural or perforated springs and has special hygienic properties. Its composition, physicochemical and organoleptic characteristics and its temperature must remain constant and it can be classified as possessing properties favourable to health. The term *natural* indicates that, unlike tap water, mineral water must be bottled at the origin as it flows from the source, and must be pure without purification treatments. Nonetheless, natural mineral water can be treated, within certain limits, with ozone-enriched air (11, 12) to remove compounds of iron, manganese, sulfur and arsenic: this argues against a product of entirely pure origin. Moreover, the absence of disinfection treatments requires the use of advanced systems for extraction and bottling, justifying significantly higher costs than for other types of water.

In the past, natural mineral water has been used at spas, including water with therapeutic properties (13), although for limited periods of time and under medical supervision. More recently, the use of natural mineral water as table water has spread, partially replacing water distributed by aqueducts.

In the 1980s, the consumption of mineral water in Italy was 1.5 billion Liters per year, increasing to six billion Liters per year in the early ’90s. In 2010, according to estimates by Global Drinks (14), world consumption of mineral water equals 218 billion Liters per year. Europe and America have the highest per capita consumption > 80 Liters per year. Asia and Africa have the lowest per capita consumption (15 and 6 Liters per year, respectively).

According to the presence of carbon dioxide, natural mineral waters can be divided into five categories (4):
a) **Totally degassed water**, if the free carbon dioxide at the source was totally eliminated;
b) **Partially degassed water**, if the free carbon dioxide at the source was partially eliminated;
c) **Naturally carbonated water**, if the content of carbon dioxide after decanting and bottling is the same as at source, taking into account the reintroduction of a quantity of gas from the aquifer water equal to that released in the course of production;
d) **Water fortified with gas from the spring**, if the carbon dioxide content after decanting and bottling is greater than at the source;
e) **Carbonated water**, if carbon dioxide that is not drawn from the aquifer has been added.

Carbon dioxide is advantageous because it prevents the “aging” and oxidation of mineral water, limits bacteria proliferation (it has bacteriostatic properties), facilitates digestion (increases motility and gastric secretion), and provides greater thirst-quenching properties because of its slight anesthetic action on the taste buds. Nevertheless, the consumption of aerated water is not recommended in infants and subjects with meteorism.

Depending on the concentration of minerals in a liter of water, mineral waters are classified as follows (4):

- **Minimally mineralized** (DR < 50 mg/L): this water is low in minerals, promoting diuresis and facilitating the removal of small kidney stones. It is indicated in low sodium diets and for children.
- **Oligomineral** (DR between 50 and 500 mg/L): the reduced mineral content makes excellent table water, suitable for daily consumption. It is suitable for low sodium diets because it has a diuretic action.
- **Rich in mineral salts** (DR > 1500 mg/L): this water has a high salt content and is usually used for therapeutic purposes. Its consumption may be suggested by a doctor.

**Mineral water vs tap water**

Data in the literature show advantages and disadvantages up to natural mineral waters intended for human consumption (15–17). The National Institute of Statistics (ISTAT, Italy) data demonstrate that the consumption of mineral water has gradually overshadowed that of tap water, which is generally less palatable because of the presence of secondary products of disinfection; in other cases (aqueducts of the cities located near the shore of the Po river), the tap water spontaneously tastes bad. The substantial consumption of mineral water, particularly among children, is caused by factors including eating habits that are oriented towards natural products and by doubts about the reliability of home tap water.

Natural mineral water is generally more pleasing in organoleptic terms because it is pure at the source and it does not undergo disinfection treatments. Chlorine is usually added to tap water, which combines with organic substances present in surface waters and causes the formation of undesirable byproducts. While respecting the limits imposed by law, sometimes chlorine gives water an unpleasant taste. In contrast, mineral waters may have organoleptic qualities that are useful for health and wellbeing while remaining within limits for certain “undesirable” or “contaminant” substances (such as cadmium, cyanide, pesticides, and benzene) that are generally more restrictive than the limits imposed on tap water (12). Mineral water temperature at the source is an important indicator related to the hydrogeological setting and it must, therefore, be constant over time. For tap waters, neither temperature nor the presence of carbon dioxide are relevant factors: as with the pH value, carbon dioxide is considered only to the extent that it affects problems related to corrosion in supply pipes.

Among its disadvantages, natural mineral water may contain residues released by its
bottling containers, especially those made of polyethylene terephthalate (PET). If stored for months in unsuitable places or in warm or dubiously hygienic conditions, microorganisms harmful to human health can develop or the water can lose the organoleptic characteristics present at the source. It is clear that the quality of bottled water storage is essential for consumer protection (18).

In Italy, the production of plastic bottles involves the use of 350 tons of PET per year, causing the emission of 910,000 tons of CO₂ into the atmosphere (19). Today, only one third of the plastic bottles are collected separately and recycled. Glass containers are used only for 19% of mineral waters, although they are more recommended microbiologically than plastic ones. It has been demonstrated that plastic bottles can favor microbial reproduction when storage conditions are not optimal (20). Natural mineral water has also a high environmental impact, since it must be transported, consuming fuel and creating air pollution. 18% of mineral water bottles are transported by train; the remainder are transported by road (19).

Some authors have shown that bottled water is not always better than tap water (21, 22). People often do not appreciate tap water because it is cheap; sometimes the public considers the low cost as a lack of guarantee. In fact, consuming tap water would be the best solution both because of its lower cost and because of its environmental and health safeguards (23).

In America, tap water and bottled water are equally safe, so the choice is determined by personal preference. The Food and Drug Administration (FDA) regulates bottled water, while the Environmental Protection Agency (EPA) regulates tap water. Both agencies use the same standards to ensure safety (24, 25).

In Italy, the reference standards (2, 3) for the quality of water intended for human consumption require that the waters be subjected to physicochemical and microbiological tests, generally carried out by the local health authority and by the Regional Agency for Environmental Prevention (ARPA, Italy). The water service management companies are responsible for ensuring water quality up to the water meter, after which it is the responsibility of the landlord or the condominium to ensure that the pipes are in good condition to prevent degradation in the quality of water or transmission of infectious diseases by inhalation (e.g. *Legionella* spp.) (26) or by direct contact (e.g. *Pseudomonas aeruginosa*) (27). Furthermore, some microorganisms defined as “undesirable” (e.g. protozoa, helminths, algae and fungi), although of environmental origin, can constitute a sanitary problem (28, 29).

The public has an incorrect impression of the benefits that would result from the use of tap water because of the lack of accurate and adequate information. In Italy, the most recent campaign in defense of tap water occurred in 1977, but the goal was to draw the attention of the authorities to the maintenance of the territory and to wasteful and irresponsible consumption. To increase consumer water awareness, in 2012 a national distribution enterprise promoted an information campaign in collaboration with Federutility (Federation of energy and water companies). In about 500 Italian stores, tap water quality parameters were displayed on informational sheets, reporting the main chemical parameters, in compliance with the directions given by the Institute of Health (ISS, Italy). Moreover, a million brochures that reported the significance of each parameter were distributed. In 2010, the same company had already invested a million euros to launch a major promotional campaign to encourage the consumption of tap water or mineral water from nearby sources as rational choices to limit the environmental harm caused by the bottled water market.
The role of marketing in the consumption of water

Although bottled mineral water can augment the dietary intake of certain minerals, their consumption is often based more on advertising or promotional solicitations than on the intrinsic qualities of their composition.

In 1970s Italy, marketing transformed a primary need into a differentiated choice based on taste, flavor and beneficial properties. Over time, a “society of the need” has transformed into a “consumer society”. Today the Italian market offers waters including “waters that evoke therapeutic spas”, “calcium-free water”, “water of health and beauty”, “water of purity”, “sparkling mineral water”, “low-sodium water” and “fitness water” (30).

In the light of market analysis showing that Italians are increasingly sensitive to ‘social’ issues, companies in the water sector often support causes including making bottles with low environmental impact and providing economic support to NGOs (Non-Governmental Organizations) advancing social causes. The logic that conditions these commitments is to guide consumers to purchase not only a product but also an underlying set of values. Among the marketing activities, mineral water companies include consumers analyses to identify the needs and desires influencing their choices.

The strong global competition in today’s markets has led many mineral water companies to enhance the attractiveness of products through packaging, transforming the historic glass bottle into a design element. New materials are offered including bottles made of “eco-sustainable vegetal plastic” or reduced levels of plastic used for the production of PET bottles, making the bottles putatively “eco-friendly” (31).

Conclusions

The choice between consumption of mineral water or tap water is a privilege of advanced economies. The goal of constantly increasing public health protection has created pressure to update policies for the prevention and control of risks associated with the consumption of water (32). Consequently, rules for the quality of different types of water in all cases guarantee high safety standards by both companies and the health authorities. Only increased knowledge of the types of water, their parameters and their classification criteria will guide the public to a rational choice, avoiding cultural misinformation and “partisan” advertising messages (18). It is important to provide consumers with timely information that is as objective and free of partisan interests as possible to enrich public knowledge, and not simply to denounce critical issues. In the face of increasing water shortages, it is also necessary to establish a strategy to reduce the waste of mineral water and tap water to prevent further depletion of groundwater and water networks.

Riassunto

Acque minerali o acque di rubinetto? Un tema dibattuto

Il consumo di acque minerali è in aumento a causa delle frequenti e ingiustificate segnalazioni di contaminazioni della rete idrica. Alcuni autori hanno dimostrato che non sempre le acque imbottigliate sono migliori di quelle di rubinetto. Le acque minerali sono più gradevoli dal punto di vista organolettico perché, essendo pure all’origine, non subiscono trattamenti di disinfezione. In realtà, sono caratterizzate da una propria facies microbiaca soggetta ad alterazioni durante il ciclo produttivo.

È necessario fornire ai cittadini gli strumenti necessari per una scelta critica della tipologia di acqua da consumare, non esclusivamente basata sulle caratteristiche organolettiche o condizionata delle strategie di marketing.
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Corresponding Author: Prof.ssa Maria Teresa Montagna, Department of Biomedical Sciences and Human Oncology, University of Bari Aldo Moro, Piazza Giulio Cesare 11 – Policlinico, 70124 Bari, Italy

e-mail: mariateresa.montagna@uniba.it