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A Reflection on the Modernity of Bottled Water

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Abstract

As a ubiquitous beverage in contemporary society, bottled water has emerged through processes of commercialization, industrialization, technologization, and globalization, offering a convenient means of accessing drinking water. Nevertheless, the rapid expansion of the bottled water industry has also engendered a series of challenges, including potential health risks, excessive energy consumption, ecological degradation, high economic costs, and social inequities. To address these issues, it is essential to promote the development of public drinking water infrastructure alongside the bottled water sector. Moreover, technological innovations in water provision should be applied judiciously to ensure their sustainability and equity. While engaging with the global bottled water market, safeguarding local autonomy over water resources is equally critical. In particular, government authorities should strengthen efforts to mitigate water pollution at its source, allocate greater resources toward public water systems, and establish a sustainable drinking water framework in which public supply plays a leading role, complemented by bottled water as a secondary option.

Keywords

Bottled Water, Sustainable Drinking Water Model, Philosophical Reflection

1. Introduction

The evolution of human society has been accompanied by significant shifts in water consumption practices. As late as the late 20th century, bottled water remained a niche commodity; yet, it has since proliferated into a ubiquitous daily necessity, underpinning a multi-billion-dollar global market (Bouhlel et al., 2023). The genesis, expansion, and prevalence of bottled water are inextricably linked to modern economic development, as well as to broader transformations in technology, society, and culture.

Existing scholarship has predominantly scrutinized the technical and commercial dimensions of bottled water—namely production, marketing, safety monitoring, and market dynamics. For example, Li et al. trace the industrial trajectory of bottled water in China (Li, Wang, & Liang, 1999), offering forecasts for future development. Zhu et al. examine brand equity through a marketing lens, positing that education, age, and income are primary determinants of consumer preference. In the realm of safety (Zhu et al., 2003), Ma Qunfei underscores the critical necessity of controlling *Pseudomonas aeruginosa* in production environments. Additionally (Ma, 2003), Ma Tingyu utilizes the Structure-Conduct-Performance (SCP) paradigm to analyze the structural and behavioral efficacy of the Chinese bottled water industry (Ma, 2018).

However, there remains a paucity of in-depth research addressing the social attributes and cultural implications of this phenomenon. Consequently, this study investigates the history of bottled water through the lenses of commercialization, industrialization, technological advancement, and globalization. In doing so, it aims to critically reflect upon the modes of drinking water consumption in contemporary society.

2. The Commercial Development of Bottled Water and the Dominance of Public Water Infrastructure

Historically, drinking water existed primarily as a natural resource. As society developed, increasing emphasis was placed on the construction of public water infrastructure. However, since the modern era—and particularly since the late 20th century—the commercialization of drinking water has accelerated rapidly. Against this backdrop, it is imperative to focus on public water infrastructure and ensure its dominant role in society.

2.1. Drinking Water: Transitioning from a Natural to a Public Resource

As a biological necessity, drinking water has always played a pivotal role in social life. In traditional societies, individuals freely accessed natural water sources such as rivers, lakes, and groundwater. During this period, drinking water was essentially a natural resource, and its acquisition reflected a direct dependency between humanity and nature. Concurrently, early forms of water management emerged through government administration or autonomous rural governance, with water wells serving as a representative example.

Historical records illustrate this early management. For instance, the *Zhouyi* (Book of Changes) from the Zhou Dynasty notes, "If the well is muddy, it cannot be drunk; an old well without birds," (Yang & Zhang, 2022) implying that silt accumulation renders water turbid and undrinkable, leading to abandonment. The *Book of the Later Han* records, "Dredge the well and change the water on the Summer Solstice," (Fan, 2007) indicating a routine practice of annual well maintenance. Furthermore, Xu Guangqi's *Complete Treatise on Agriculture* in the Ming

Dynasty states, "A cover prevents loss and uncleanliness; thus, ancients covered their wells," (Xu, 2002) highlighting the use of covers to prevent evaporation and contamination. Internationally, ancient governments also prioritized public water infrastructure. For example, ancient Greek city-states constructed cisterns to ensure household water supply (Angelakis et al., 2012), and the Valens Aqueduct was completed in the late 4th century to supply Constantinople (Crow, 2012).

As governmental bodies increasingly prioritized public water infrastructure, the modes of water consumption underwent significant changes, and drinking water began to evolve into a public resource. In the United Kingdom, attention to urban water supply dates back to the 13th century, with facilities provided by municipal corporations (Stern, 1954). From 1581 to 1882, the London Bridge Waterworks was responsible for supplying London (Tomory, 2015). In the United States, the tap water industry began relatively later, with the country's first steam-powered pumping station, the Fairmount Waterworks, established in Philadelphia in 1801 (Melosi, 1999).

In China, the first water plant, the Yangshupu Waterworks, was built in Shanghai in 1883. Subsequently, the Jingshi Tap Water Company was founded in Beijing in 1908 and officially began supply in 1910 (Gu & Gu, 1984). Following the founding of the People's Republic of China in 1949, a more comprehensive urban water supply system was gradually established. From 1949 until the Reform and Opening-up period, urban tap water was managed under a planned economy model. Since the Reform and Opening-up, the sector has undergone market-oriented reforms while remaining under state macro-management (Zhang, 2009).

2.2. The Commercialization of Drinking Water in the West

Initially, bottled water was marketed as a subsidiary product of spa therapies, with a strong emphasis on its medicinal value. The American bottled water industry originated in 1767 with sales at Jackson's Spa in Boston, though its initial growth trajectory was relatively sluggish (Guo, 2019). It was not until the 19th century, when glass manufacturers introduced the glass press—thereby significantly enhancing the efficiency of bottle production—that the industry experienced accelerated development (Hall, 2009).

While the European bottled water industry developed later than its North American counterpart, it eventually achieved a larger industrial scale. Vichy, France, was a renowned destination for spa treatments. Between the late 19th and early 20th centuries, the region introduced mineral water brands such as Vichy St-Yorre and Vichy Célestins, achieving large-scale production by the 1860s (Dege, 2011). In the United Kingdom, the development of bottled water was inextricably linked to spa therapies and maritime activities. For instance, trade in bottled spring water emerged during the Tudor era (1485-1603). By 1700, bottled water from Hampstead Wells was being sold on Fleet Street in London, and Malvern Soda Water was debuted at the Great Exhibition of 1851.

In the post-20th century era, bottled water expanded into the mass market, with its function as a hydration source gradually superseding its medicinal value. During this period, numerous multinational beverage corporations propelled the commercialization and industrialization of the sector. For example, Nestlé entered the market in the mid-20th century, progressively acquiring brands such as Perrier and San Pellegrino (Wu, 2022). Coca-Cola entered the bottled water market in the 1960s, followed by PepsiCo in the 1970s. These commercial and industrial production processes gradually transformed bottled water into a daily consumer good. Illustrating this trend, the per capita annual consumption of bottled water in the United States surged from 61 liters to 160 liters between 1999 and 2018 (Parag & Elimelech, 2023).

2.3. The Commercialization of Drinking Water in China

The development of the bottled water industry in China has traversed a trajectory of introduction, assimilation, and autonomous production. Early bottled water in China was predominantly characterized by mineral water. In 1930, the German merchant Rodevy established China's first mineral water plant in Qingdao, producing "ALAC" health water, which was the predecessor of Laoshan Mineral Water (Xia, 2020). Until 1967, Laoshan Mineral Water remained the sole domestic manufacturer of mineral water; its products were primarily exported to Southeast Asia and Hong Kong, SAR, with limited supplies provided to large hotels and guesthouses on the mainland. In 1967, the Guangdong Longchuan Mineral Beverage Factory began producing "Huoshan" brand mineral water (Kuang, 1990). This marked the first mineral water product independently produced by the Chinese people, laying a foundational basis for the development of the national bottled water industry.

Following the Reform and Opening-up, and concomitant with socio-economic development, bottled water gradually evolved into a daily beverage. In 1982, the state officially designated bottled water as a product under planned management within the beverage category for the first time, marking the beginning of a rapid development phase for the industry (Du, 2002). In 1990, leveraging the advantages of Shenzhen as a window for reform and opening-up, China Longhuan Co., Ltd. pioneered the introduction of a purified water production line from Hong Kong, SAR. By 1991, it commenced production of "C'estbon" (Yi Bao) purified water in Shenzhen, effectively filling a gap in the market (She, 2024). Subsequently, the Wahaha Food Group entered the purified water market in 1996 and ascended to the top sales position within two years (Wang, 2008). Driven by factors such as water source accessibility and cost-effectiveness, purified water began to command the majority of the bottled water market share from 1996 onwards.

Entering the 21st century, bottled water has become a necessity in the daily lives of many. The industry has transitioned into a stage of diversified development characterized by a multiplicity of enterprises and product categories. For instance, in 2023, the market shares of major brands—Nongfu Spring, C'estbon, Ganten, Wahaha, and Master Kong—stood at 23.6%, 18.4%, 6.1%, 5.6%, and 4.9% respectively, collectively occupying the lion's share of the entire market.[1] In terms of product categories, the market now encompasses mineral water, mineralized water, purified water, and natural water. Regarding quality segmentation, the market has stratified into general and premium categories. Illustrating this trend toward premiumization, Tibet Water Resources Ltd. launched its high-end mineral water "Tibet 5100" in 2006, followed by JDB Group's introduction of the premium brand "Kunlun Mountains" in 2010.[2]

2.4. Ensuring the Primacy of Public Water Provision

The proliferation of bottled water has transformed water from a natural and public resource into a commodity. While this commodification addresses the hydration needs of a specific demographic, it simultaneously engenders a series of critical issues concerning sanitary safety, environmental degradation, and inequitable resource allocation.

regarding hygiene, certain enterprises engage in malpractices such as substituting inferior products for superior ones, false labeling, and the illicit use of additives. For instance, some manufacturers masquerade mineralized tap water as natural mineral water (Ding, 1997), while other illicit producers operate without basic disinfection facilities or quality inspection equipment. Evidently, as a vital public necessity, drinking water cannot be managed solely through mechanisms of privatization and commercialization (Xiao, 2007). Even within the sphere of commercial operation, strict quality standards and rigorous regulatory supervision are mandated.

Ecologically, the high energy and resource consumption characteristic of bottled water production has become increasingly conspicuous. Compared to tap water, the production, packaging, and transportation of bottled water consume vast amounts of energy and fossil fuels (Tang, 2007), alongside a significant water footprint during production. Specifically, the energy consumption of bottled water is approximately 200 times that of tap water (Gleick & Cooley, 2009); furthermore, the production of one liter of bottled water consumes roughly two liters of source water (Fang, 2008). Additionally, the plastic packaging is difficult to degrade, resulting in severe environmental pollution. For example, of the plastic bottles consumed in 2016, less than half were collected for recycling, and only 7% were repurposed into new bottles. The vast majority ended up in landfills or the marine environment (Wang, 2017). This implies that bottled water production necessitates strict regulation and guidance grounded in holistic societal interests.

In terms of resource allocation, bottled water consumption is predicated on individual purchasing power rather than principles of equitable distribution. Consequently, bottled water does not serve as the primary solution for public water security, but rather as a mechanism for water resource redistribution that operates

[1]China's "Water War" Intensified in 2024: Market Share Concentrates Towards Leading Players. China Business Journal, 2025-01-06.

[2]Returning to the 1-Yuan Era: The Conflict over Packaged Drinking Water Reignites. China Business Journal, 2024-11-18.

atop the baseline of public safety. A 2023 United Nations report noted that progress toward universal access to safe drinking water is significantly off track; the expansion of the bottled water market has slowed this progress by diverting attention and financial resources away from the development of public water supply systems. It is estimated that half of the annual global expenditure on bottled water would suffice to ensure years of clean tap water access for hundreds of millions of people currently without it (Ferrier, 2001). In China, 70% of bottled water is sourced from water-deficient or water-stressed provinces (Liu, 2015). Moreover, the significantly higher price of bottled water relative to tap water increases the cost of living for the general populace. Therefore, it is imperative to guarantee the primacy of public water resources and to intensify investment in public water infrastructure.

While the commercialization of bottled water reshaped drinking water as a market commodity, this transformation would not have been possible without parallel advances in extraction, purification, and packaging technologies—a dynamic that the following section examines in detail.

3. The Technological Development of Bottled Water and the Rational Application of Scientific and Technical Means

The advancement of associated scientific and technical fields—specifically water extraction, purification, and packaging technologies—has significantly propelled the growth of the bottled water industry. However, this progress has simultaneously engendered challenges regarding the reconciliation of technology with nature, human health, and the public interest.

3.1. The Development of Water Extraction Technology

Water extraction technology encompasses water lifting, groundwater exploration, and well-drilling technologies. The evolution of water lifting technology has provided ample raw materials for the large-scale development of the bottled water industry. In early human history, water extraction relied primarily on human and animal power. For instance, between approximately 4000 and 2000 BCE, various ancient civilizations began utilizing wooden hand-operated devices to lift water from rivers and wells. In China, during the Ming and Qing dynasties, the windlass (*lulu*) was employed for the same purpose (Yannopoulos et al., 2015). Following the Industrial Revolution, the English engineer Thomas Savery invented the steam pump in 1698. To date, a diverse array of lifting equipment has been invented, including piston pumps, centrifugal pumps, and vacuum pumps.

Advancements in groundwater exploration technology have further expanded the scope of human water resource exploitation. Initially, detection relied primarily on surface features, such as vegetation and drainage patterns, to locate groundwater (Paterson, Bosschart, & Li, 1989). In the 1950s, the resistivity method was introduced for groundwater exploration. This technique determines the presence of groundwater by measuring the electrical resistivity encountered by an underground current over a unit distance; while it boasts a measurement range of hundreds of meters, it is notably time-consuming (Fu, 1983). By the 1980s, the electromagnetic method began to be applied. This method locates groundwater by transmitting electromagnetic waves and measuring variations in surface signals. It possesses the advantages of speed, high resolution, and low operational costs, though it is constrained by high equipment costs and complex data interpretation (McNeill, 1988).

The development of well-drilling technology has enabled the large-scale utilization of groundwater resources. Prior to 1949, China primarily employed the "bamboo bow method" for well digging. This traditional technique utilized a human-operated treadle to repeatedly flex and recoil a wooden bow, driving a drill bit to impact the stratum vertically. In 1952, China imported wire-rope percussion drilling rigs from the Soviet Union. Entering the 1960s, the nation began to independently develop percussion and rotary drilling rigs. Percussion rigs utilize the gravity of the drilling tool itself to impact the stratum through vertical reciprocating motion, whereas rotary rigs rely on the rotational motion of the drilling tool to crush rock and form the borehole (Xu, Wang, & Zuo, 2012). Subsequently, advanced drilling equipment was successfully developed, including truck-mounted combined percussion-rotary table rigs and truck-mounted fully hydraulic powerhead rigs (Zhang, 2005).

3.2. The Development of Water Purification Technology

The industrial and commercial expansion of bottled water hinges on advancements in purification technology. As the pivotal step ensuring the safety and stability of bottled water quality, purification primarily encompasses filtration, disinfection, and desalination processes.

Filtration is the process of removing impurities from water, typically categorized into coarse filtration, precision filtration, and ultrafiltration. Coarse filtration is a traditional gravity-driven process, typically employing a physical system layered with stones, gravel, coarse sand, and fine sand from bottom to top (Li & Wang, 1994). Historically, the world's first public slow sand filter was constructed in Paisley, UK, in 1804; subsequently, the first rapid sand filter was built in Somerville, USA, in 1884. Over time, diverse filter types evolved, including four-valve, double-valve, valveless, siphon, V-type, pressure, and variable cross-section filters (Yu, 2006). Precision filtration generally utilizes hermetically sealed metal containers partitioned into upper and lower chambers to separate raw water from filtered water, commonly employing membrane or cartridge filtration methods. Ultrafiltration (UF) utilizes pressure as a driving force, allowing water and soluble substances to pass through micropores (0.005 - 1 μm) while retaining organic macromolecules, algae, molds, bacteria, and viruses (Li & Chen, 2015). The phenomenon of membrane separation was first revealed by the osmosis experiment using a pig bladder in 1748, with membrane separation technology entering industrial application in the mid-1960s (Leng, 1993).

Disinfection refers to the elimination of pathogens and harmful substances from water, primarily divided into chemical and physical methods, with the former being more prevalent. Chemical disinfection achieves sterilization by using chemical agents (such as liquid chlorine, sodium hypochlorite, and ozone) to destroy microbial enzymes or cell structures. Physical disinfection employs physical means (such as heat, ultraviolet light, and ultrasound) to cause protein denaturation or genetic mutation in bacteria. Modern drinking water disinfection originated in 1897 when bleaching solution was used in the UK pipe network to control typhoid. By 1902, the Middelkerke Waterworks in Belgium implemented continuous disinfection using bleaching powder, marking the establishment of chlorination as a standard treatment process. The early 20th century saw the emergence of ozone and UV disinfection for pathogen elimination, followed by the introduction of chloramine and chlorine dioxide in the mid-20th century to mitigate phenolic tastes and odors (Zhang & Lu, 2016).

Desalination is the process of removing salts from water, utilizing methods such as distillation, ion exchange, electrodialysis (ED), and reverse osmosis (RO). Distillation, the earliest desalination technology, is primarily applied in seawater desalination. Ion exchange is a traditional process that utilizes functional resins to selectively replace anions and cations (inorganic salts) in water (Chu, Jiang, & Chu, 1996); its modern industrial application began with the advent of synthetic resins in the 1940s (Li, Hu, & Cui, 2014). Although the equipment is simple, the resin regeneration process generates acid-alkali waste, posing environmental risks. Electrodialysis (ED), developed in 1950, features a core component of charge-selective polyelectrolyte membranes that migrate electrolyte ions directionally to achieve desalination (Zhang et al., 2016). Reverse Osmosis (RO) is the reverse of natural osmosis, driven by high pressure to force the solution through a semi-permeable membrane, physically separating the solvent from the solute (Qu & Sun, 2019). Since the manufacturing of RO membranes in 1977, this technology has been capable of retaining over 95% of dissolved salts, microorganisms, and colloids while maintaining high water flux (Xu et al., 2010).

3.3. The Development of Bottled Water Packaging Technology

Packaging technology constitutes a fundamental prerequisite for the widespread dissemination of bottled water. In the early 19th century, the primary vessel for bottled water was the glass bottle, fabricated via the "mouth-blowing" technique, wherein molten glass was blown into a mold and subsequently cracked off the blowpipe. By the 1880s, the invention of the semi-automatic bottle-blowing machine significantly augmented production efficiency, laying the groundwork for the commercial expansion of bottled beverages (Talbot, 1974). In 1903, American engineer Michael Owens invented the world's first fully automatic bottle-making machine in Toledo, thereby realizing the full mechanization of glass bottle production (Miller & Sullivan, 1984). However, the inherent limitations of glass bottles—namely their heavy weight, fragility, and logistical inconveniences regarding transport and storage—constrained the large-scale circulation and popularization of bottled water. By the early 1960s, aluminum cans gradually emerged as a mainstream packaging solution; however, their usage was found to compromise the water's flavor profile (Li, 2016).

The advent of the plastic bottle precipitated a revolutionary shift within the bottled water industry. During the 1960s, Polyethylene Terephthalate (PET) was utilized for manufacturing food trays and general packaging, yet it had not been applied to bottle fabrication. In 1973, DuPont manufactured the first PET bottle, characterized by its high tensile strength, lightweight nature, and superior transparency. Combining the optical clarity of glass with the shatter-resistance of aluminum cans, PET bottles rapidly supplanted traditional packaging materials (Hawkins, Potter, & Race, 2015). In 1976, PepsiCo became the first to utilize PET bottles for beverage packaging, after which the material was progressively adopted across the beverage spectrum (Weissmann, 2017). Concomitant with the rise of the sustainable development paradigm, bottled water enterprises have increasingly prioritized the environmental sustainability of packaging materials. For instance, in 2019, the American bottled water brand Dasani introduced rPET bottles composed of 50% plant-based renewable and recycled PET materials.[3]

3.4. The Rational Application of Scientific and Technical Means

Scientific and technical advancements play a pivotal role in the commercialization, industrialization, and standardized production of bottled water. However, it is imperative to acknowledge the dual nature—both positive and negative—of these technological interventions.

With the advancement of water extraction technology, the scale of water resource utilization has expanded continuously. This has precipitated issues such as groundwater depletion, land subsidence, and ecological degradation in certain regions. For instance, in Texas, USA, and the Great Lakes region bordering the US and Canada, the massive extraction of water by bottling plants has caused rapid declines in water levels, inflicting significant losses upon local farmers, fishermen, and other communities dependent on these resources for their livelihoods (Chen, 2006). Evidently, while developing extraction technologies, it is crucial to strengthen the supervision and management of related equipment and to seek a balance between technical efficiency and social value; otherwise, it may easily lead to predatory resource exploitation.

The development of water purification technology has also given rise to issues such as the loss of nutritional substances and secondary pollution of drinking water. For example, reverse osmosis (RO) systems, while effectively removing impurities, also strip away 92% to 99% of beneficial minerals such as calcium, magnesium, and iron, alongside other elements like lead and fluoride (Kamalapriya et al., 2023). Furthermore, disinfection by-products—such as chloroform and bromodichloromethane—can cause secondary pollution in drink-

[3]Dasani Launches Hybrid rPET Bottle. China Packaging, 2019, 39(11), 28.

ing water (Villanueva et al., 2023). Thus, alongside the development of filtration, disinfection, and desalination technologies, attention must be paid to their health implications. In particular, it is necessary to shift away from the "pollute first, purify later" model of water utilization and instead address water pollution at its source.

While advancements in packaging technology have facilitated the widespread dissemination of bottled water, they have also engendered problems regarding resource consumption and secondary pollution. A prime example is microplastic contamination arising from plastic bottles. Microplastics are defined as plastic particles with a diameter of less than 5 mm. Smaller microplastics are more susceptible to ingestion by human tissue cells, thereby posing potential risks to human health (Zheng et al., 2024). Sources of microplastics in bottled water include contamination of the raw water and the physical friction between the bottle cap and the neck during opening (Singh, 2021). Currently, microplastic pollution has permeated the entire ecological chain, including water resources, soil, and biological communities (Rillig, 2012). It should be noted, however, that the long-term health effects of chronic microplastic ingestion remain subject to significant scientific uncertainty. While existing studies have confirmed the widespread presence of microplastics in bottled water and their potential to penetrate biological tissues, consensus has not yet been reached regarding specific dose-response relationships, cumulative health impacts, or intergenerational effects.

This uncertainty does not negate the risks posed by microplastics; rather, it highlights the limitations of current toxicological knowledge and underscores the ethical challenge of applying precautionary principles in drinking water technologies. From a philosophical standpoint, the normalization of uncertain technological risks in daily consumption reflects broader tensions between convenience, scientific uncertainty, and public health governance.

Consequently, in the application of scientific and technical means, beyond focusing on production efficiency and economic benefits, equal weight must be accorded to issues such as human health and environmental protection.

4. The Globalization of Bottled Water and Regional Drinking Water Autonomy

The commercialized and industrial production of bottled water has propelled its globalization, catalyzing the worldwide dissemination of associated drinking practices, standards, and cultures. Simultaneously, it has elevated social issues related to bottled water into global concerns.

To further theorize the globalization of bottled water, this paper draws on David Harvey's concept of "accumulation by dispossession". Extending Marx's analysis of primitive accumulation, Harvey argues that contemporary capitalism continues to expand through non-violent yet coercive mechanisms, including financialization, privatization, and the commodification of public and common resources such as land, water, and knowledge (Harvey, 2017).

From this perspective, water is not merely a natural resource but a form of collective wealth embedded in social and ecological systems. Its privatization therefore constitutes a form of dispossession, whereby public access and collective control are replaced by corporate ownership and market-mediated distribution. The global bottled water industry exemplifies this process by enclosing local water sources and integrating them into transnational commodity chains, often provoking social resistance and conflict.

4.1. The Globalization of the Bottled Water Industry

The globalization process of bottled water commenced in the mid-20th century. Early bottled water was primarily produced in European and American regions and was predominantly produced and sold locally. It was not until the advent of PET bottles in the 1970s—which provided a lightweight and portable packaging format and significantly reduced transportation costs—that a critical technological prerequisite for global expansion was established. Concurrently, the global strategic deployment of major international beverage corporations served as a significant driving force behind the industry's rapid expansion. For instance, by 2004, the sales volume of the "Big Four"—Nestlé, Danone, Coca-Cola, and PepsiCo—accounted for 30% of the global market (Rillig, 2012). Notably, Nestlé ranked first worldwide, with an annual mineral water production of 6.4 million tons, representing approximately 60% of European production and 15% of global output.

With the advent of the Reform and Opening-up policy, renowned international bottled water brands began to penetrate the Chinese market. For example, Coca-Cola invested in establishing a factory in Beijing in 1979; PepsiCo entered Shenzhen in 1981 (Jie, 2016); the famous French brand Evian entered the Chinese market in 1984 (Chang, 2012); and in 1996, Danone formed a joint venture with Wahaha, becoming the controlling shareholder (Xu, 2012). Parallel to this, with the continuous growth and strengthening of domestic enterprises, Chinese bottled water companies also began to enter the international market. For instance, by 2003, Wahaha's products were being exported to countries such as France, Germany, Thailand, and the United States (Miller, 2004); Nongfu Spring announced its globalization strategy in 2016 and acquired the Otakiri Springs plant in New Zealand in 2017.[4]

The essence of the bottled water globalization process lies in the transformation of drinking water from a localized resource into a standardized, tradable industrial product. Water resources are no longer confined to the administrative domains of geography and community but are instead embedded within global capital flows and supply chains, evolving into "commodity water" in the global marketplace.

[4]Department of Commerce of Shandong Province. (2018, June 15). Nongfu Spring's New Zealand High-end Water Project Surfaces. Department of Commerce of Shandong Province. http://commerce.shandong.gov.cn/art/2018/6/15/art_21621_3713958.html

4.2. The Globalization of Bottled Water Consumption Patterns

The globalization of the bottled water industry is not merely a process of market expansion; it also serves as a vehicle for disseminating production technologies and drinking cultures. The primary categories of bottled water include mineral water, purified water, functional water, and natural water. The proliferation of mineral water is attributed to its convenience of consumption and perceived health benefits; the rise of purified water is linked to convenience and crises regarding public water quality; the globalization of functional water is driven by specific health demands and specialized functions; while the promotion of natural water is associated with the low cost of water sources and relatively lower product standards.

The universalization of drinking water standards constitutes a crucial component of the globalization of consumption patterns. These standards primarily encompass microbiological indices, disinfectant indices, toxicological indices, organoleptic properties (sensory traits), general chemical indices, and radioactive indices (Yang, 2015). The globalization of drinking water standards originated around the mid-20th century. As European colonizers introduced water management systems to colonies in Asia and Africa, the concept of "water quality management" gradually expanded globally (Shi, 2023). Currently, authoritative international standards include the World Health Organization's (WHO) *Guidelines for Drinking-water Quality*, the European Union's (EU) *Drinking Water Directive* (Arnold, 1993), and China's *Standards for Drinking Water Quality* (GB 5749-1985) (Wang, 2014). The globalization of these standards has, in turn, bolstered the global popularization and promotion of bottled water.

4.3. The Globalization of Bottled Water Issues

As bottled water enjoys global commercial success, associated health concerns—including over-purification, artificial mineral fortification, and microplastic contamination—have escalated into global issues. Microplastic contamination, for instance, is not endemic to specific nations or brands but constitutes a ubiquitous global challenge. A 2018 study revealed that among 259 bottles of water from 11 distinct brands purchased at 19 locations across 9 different countries or regions, 93% exhibited signs of microplastic contamination (Mason, Welch, & Neratko, 2018).

The globalized production of bottled water has also precipitated environmental crises, such as water resource depletion, land subsidence, and ecological degradation in certain regions. Major bottled water conglomerates aggressively scout for water sources to expand production, often abandoning sites immediately upon resource exhaustion, thereby inflicting a cascade of ecological damage on local environments. For example, in India, the Coca-Cola Company's massive extraction of groundwater for the production of Dasani bottled water and other beverages resulted in severe water shortages across 50 surrounding villages These cases underscore the inherent conflict between bottled water enterprises and local public interests.

4.4. Ensuring Regional Drinking Water Autonomy

The advancement of global supply chains and logistics technologies has accelerated the worldwide ubiquity of renowned bottled water brands. This globalized production mode, however, undermines the drinking water autonomy of certain localities while simultaneously inflating drinking water costs and living expenses in many impoverished and remote areas. For instance, Coca-Cola's over-extraction of water sources in Mexico has compelled local residents to purchase expensive bottled water (Velázquez, Merino Lubetzky, & Cuéllar, 2021). Furthermore, with the lowest-priced bottled water typically selling for around 1 yuan (converting to approximately 2000 yuan per ton), it is nearly 500 times more expensive than tap water, which costs about 4 yuan per ton.[5]

This phenomenon exposes the unequal distribution of benefits within globalization, wherein marginalized and underdeveloped regions are susceptible to disproportionate adverse shocks.

As bottled water constitutes a daily necessity, it is imperative to address the equilibrium between globalization and local autonomy. For example, nations and regions should actively develop bottled water industries with local characteristics, tailored to their specific resource endowments. This approach allows for the production of distinctively local bottled water while also economizing on transportation costs. Additionally, governments must implement relevant laws and institutional frameworks to regulate the over-extraction of local water resources by multinational corporations, ensuring the sustainable utilization of water resources by local communities.

Research on water commodification further suggests that privatization weakens local water governance by removing decision-making authority from communities most directly affected by water extraction and use. As Blomquist and related scholars argue, effective water management depends on institutional arrangements that recognize water as a shared resource embedded in specific ecological and social contexts (Bakker, 2007).

When water is enclosed by multinational corporations, local populations are not only deprived of affordable access to water, but also dispossessed of their capacity to govern a vital element of collective life. Ensuring regional drinking water autonomy therefore requires resisting the full commodification of water and reinforcing public and community-based governance structures.

5. Conclusion

In summary, bottled water has evolved from a subsidiary commodity of mineral spas in the modern era into a daily beverage in contemporary society. Throughout its trajectory of commercialization, industrialization, technologization, and globalization, while providing a convenient mode of hydration, it has concurrently

[5]Editorial Department. (2013). Investigation on Bottled Water. Commodity and Quality, No. 27, 8-10.

engendered a series of issues including health risks, ecological destruction, energy consumption, prohibitive costs, and social injustice. Therefore, while developing the bottled water industry, it is necessary to robustly support the construction of public drinking water infrastructure; while advancing drinking water technologies, it is essential to employ scientific and technical means rationally; and while participating in the global bottled water market, regional drinking water autonomy must be safeguarded. In particular, government sectors must intensify efforts to tackle water pollution at the source and allocate greater resources to public water infrastructure, thereby establishing a sustainable drinking water paradigm led by public water supply and supplemented by bottled water.

To operationalize the proposed paradigm of "public water supply as the primary system, supplemented by bottled water", concrete policy instruments are required. These may include taxation on single-use plastic bottles to internalize environmental costs, stricter regulatory limits on groundwater extraction by commercial bottling enterprises, and increased public investment in drinking water infrastructure, particularly in rural and underserved regions.

In addition, public information campaigns that enhance trust in tap water quality, alongside transparent water quality monitoring systems, can reduce unnecessary reliance on bottled water. Such policy measures shift the focus from individual consumer choice toward collective governance of water as a public good.

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