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Report

# Evaluation of maximum contaminant levels in Turkish bottled drinking waters utilizing parameters reported on manufacturer's labeling and government-issued production licenses

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**Abstract**

A total of 189 domestic brands of bottled water consisting of natural spring, natural mineral, drinking and processed drinking types were evaluated by means of both physical and chemical parameters reported on their manufacturer's labeling and/or in government-issued production licenses. A comparison between the water composition and the maximum contaminant levels imposed by the Turkish legislation (*Resmi Gazete*, No. 23144) for all parameters is discussed. The results obtained were also compared with the European Economic Community Council Directive 98/83/EC and standards set by International Bottled Water Association, US Food and Drug Administration, US Environmental Protection Agency and World Health Organization. Results show that a significant number of bottled water brands contain some elements (e.g. sodium, chloride, sulfide, fluoride, polycyclic aromatic hydrocarbons (PAHs) and several heavy metals) above the maximum concentration allowed for bottled waters by the Turkish legislation as well as several other international organizations.


*Keywords:* Bottled water; Mineral water; Drinking water standards; Maximum contaminant level; Turkey; Food safety

## 1. Introduction

Freshwater is scarce, and resources are unevenly distributed throughout the world, with much of the water located far from human populations. Today, 450 million people in 29 countries suffer from water shortages (UNEP, 2002), and water-related concerns are the most acute in arid or semi-arid areas. Many countries with scarce water resources rely on alternative or non-conventional water resources. For example, the demand for water in Kuwait is met from three non-freshwater sources such as seawater desalination plants (53%), brackish groundwater (37%) and treated wastewater (10%) (Abu Hijleh, 1988). In such countries, consumption of bottled water is a growing practice (Al Fraij et al., 1999; Nsanze et al., 1999) and is a necessity rather than a choice because of lack of access to clean water resources. Nowadays, many people living in urban areas are increasingly consuming bottled water because it is associated with "naturalness" (Saad et al., 1998), because they object to unpleasant tastes and odors such as chlorine from municipal water supplies (Tamagnini and González, 1997), and because bottled water is often regarded as safer and healthier than tap water (Armas and Sutherland, 1999). In many parts of the world, there is also a common belief that natural (mineral) waters have beneficial medicinal and therapeutic effects (Warburton et al., 1992). Bottled water is also utilized in emergency or water shortage situations caused by natural disasters (e.g. drought, earthquake, flood and hurricane) or human-made disasters (e.g. sabotage, siege, terrorism and war), which can severely damage public and private water supplies for extended periods of time.

The popularity of bottled water can be gauged by the number of brands produced worldwide (over 5000); a significant portion of these brands are traded internationally. For instance, Turkey exports bottled water to some 60

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different countries, with the bulk of the exports to European countries (58%) and the rest to Africa and Asia (42%). In a 2002 survey, published by a market research company, it is estimated that people all over the world drink annually about $131 \times 10^9$ L of bottled water (Beverage Marketing Corporation, 2003); and western Europeans, as a whole, drink nearly half of all the world's bottled water (Williams, 2001). Western Europe is not only the largest regional market, but it is also the most developed. It is dominated by Italy, France, Belgium, Germany and Spain, in all of which per capita consumption of bottled water has exceeded the 100 L barrier in L per capita per year (Table 1). This estimated US$45 billion worldwide industry is growing faster than ever as water quality concerns, fitness and health awareness increase among the consumers (based on an estimated price of 0.35 US$ per L of bottled water, Pilat, 2002).

Table 1
Per capita consumption of bottled water in leading countries (in liters per capita per year)

| Country | Year | | | |
|---|---|---|---|---|
| | 1996 | 1997 | 2001 | 2002 |
| Italy[a] | 126.8 | 132.9 | 164.3 | 167.3 |
| Mexico[a] | 106.4 | 108.3 | 129.8 | 142.7 |
| France[a] | 97.3 | 103.3 | 131.4 | 140.4 |
| United Arab Emirates[a] | 97.3 | 101.4 | 118.5 | 133.2 |
| Belgium-Luxemburg[a] | 109.0 | 114.7 | 123.4 | 123.8 |
| Germany[a] | 96.9 | 99.9 | 106.4 | 109.0 |
| Spain[a] | 84.4 | 90.5 | 103.3 | 106.7 |
| Lebanon[a] | 48.1 | 52.2 | 85.2 | 93.9 |
| Switzerland[a] | 79.9 | 85.9 | 90.1 | 91.6 |
| Saudi Arabia[a] | 57.2 | 64.7 | 85.2 | 90.1 |
| United States of America[a] | 49.6 | 53.4 | 73.8 | 81.4 |
| Cyprus[a] | 53.8 | 65.1 | 76.5 | 81.0 |
| Czech Republic[a] | 48.8 | 53.8 | 74.2 | 79.9 |
| Austria[a] | 70.0 | 70.0 | 77.6 | 79.1 |
| Turkey[b] | — | — | 70.0 | 78.0 |
| Thailand[a] | 54.9 | 59.8 | 73.4 | 76.1 |

[a] Beverage Marketing Corporation (2003).
[b] Çelik (2003).

During the past decade, there has been a considerable increase in the consumption of bottled water in Turkey, and it is estimated that 70% of the households in Turkey regularly utilize bottled water to meet their daily drinking water requirements (Çelik, 2003). Turkish people consumed about $5.2 \times 10^9$ L of bottled water in 2002, which is approximately 78 L per capita (Çelik, 2003). The source of 89% of bottled water sold in Turkey is from protected springs, and the remaining 11% is pumped from drilled wells tapping an aquifer. However, at present, only 20% of natural spring water (still) resources and 1% of natural mineral water (sparkling) resources are utilized by the Turkish bottled water industry. The industry's annual capacity usage averages around 35–55% because of demand differences between winter/summer seasons and improving quality of tap water supplied by municipalities.

Beginning with early 1990s, especially in major cities, a drinking water crisis occurred which has boosted bottled water consumption and the number of manufacturers (brands) in Turkey (Fig. 1). There were several reasons for this water crisis: (1) faulty design and construction of the water supply networks; (2) insufficient water supply from city water distribution networks; (3) problems in the taste, purity and odor of tap water and (4) erratic power supply. All these factors resulted in public distrust of tap water. As a result, in Turkey (population about 70 million) bottled water has become a lucrative market with a US$500 million retail value (Çelik, 2003). This is a proof that the bottled water industry has done an outstanding job in marketing its product as a safe alternative to tap water, even though the price of bottled water is 250–600 times higher than that of tap water.

The purpose of this paper is to investigate the specific physical, chemical and industry characteristics of domestic brands of bottled water sold in Turkish market utilizing parameters reported on both manufacturer's labeling and in government-issued production licenses. A review of the

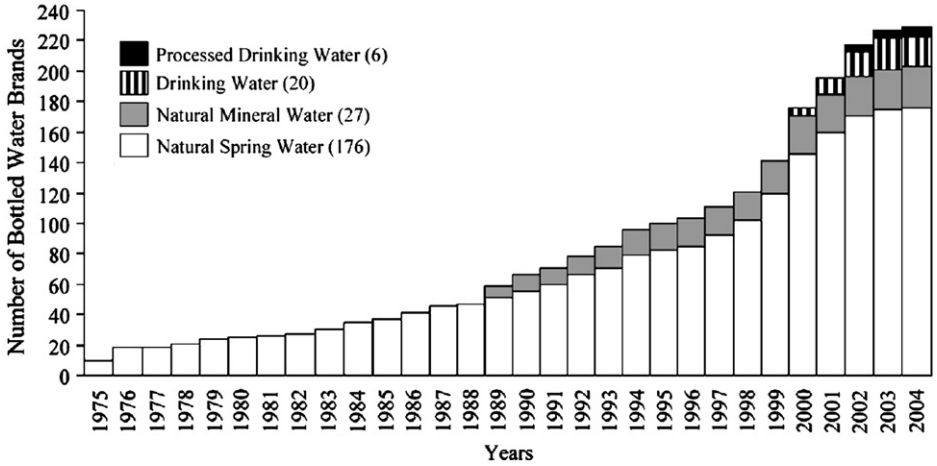


Fig. 1. Number of domestic brands of bottled water vs. their establishment years.