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DETERMINATION OF BORON IN 18 BOTTLED MINERAL WATERS IN TURKEY

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SUMMARY

The aim of this study was to determine boron contents in 18 bottled mineral waters purchased from different regions of Turkey. Azomethine-H was used as an organic reagent for the spectrophotometric determination of boron. The limit of boron content in mineral water is 2.4 mg/L. In this study, the boron concentrations in the samples are between 0.23-10.52 mg/L.

ÖZET

Bu çalışmanın amacı Türkiye'nin çeşitli bölgelerinden satın alınmış 18 maden suyu numunesinin bor içeriğinin belirlenmesidir. Spektrofotometrik bor tayininde organik reaktif olarak azometin-H kullanılmıştır. Mineral suları için bor limiti 2.4 mg/L'dir. Bu çalışmada örneklerdeki bor konsantrasyonları 0.23 – 10.53 mg/L arasında değişmektedir.

Keywords: Boron; Mineral waters; Spectrophotometrically determination; Azomethine-H.

INTRODUCTION

Boron is a member of the metalloid group of elements and has properties intermediate between metals and non-metals. The chemistry of boron is unique and, after that of carbon, it might be the most complex of elements (1).

Boron can release to the environment in a variety of ways. It is naturally present in many silicate minerals and therefore found in many soils. The mean concentration of boron in the earth's crust is 10 μg/g. Many factors

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like soil type and pH affect the boron concentration in soils. The ocean contains an average boron concentration of 4.6 mg/L. Boron also enters the environment from a number of anthropogenic activities. The worldwide boron consumption leaders are glass products and detergent products. Other uses include metal alloys, fire retardants, and chemical fertilizers. Of these, the majority of boron that enters water sources originates in detergents and fertilizers (2).

Boron is an essential micronutrient of plants for normal growth and optimum crop production. However, in excessive amounts it becomes a herbicide. In animal experiments, it has been showed that boron has an adverse effect on reproduction system. It also shows some developmental effects (3). The toxic effect of boron on human is not confirmed yet but some harmful effects have been noted. They depend on the applied dose, time and frequency of exposure. Some evidences show that long-term consumption of water or food products including high boron content causes malfunctioning of cardiovascular, nervous, and alimentary systems of humans and animals. On the other hand, the effects of boron on mineral metabolism and its potential role as an inhibitor of osteoporosis in human have been investigated. The results of the *in vivo* experiments also show that boron is a trace element that can affect the metabolism or utilization of numerous substances involved in life processes, including calcium, copper, magnesium, nitrogen, glucose, triglycerides, reactive oxygen, and estrogen (4).

Considering the effects of boron on human health, World Health Organization (WHO) recommended a tolerable daily intake of 0.2 mg/kg body weight (5) and a guideline value of 2.4 mg/L for drinking water (6).

A number of analytical techniques ranging from a simple potentiometric method to a method requiring a nuclear reactor have been used for boron determination. Several complexing agents are commonly used for the spectrophotometric determination of boron in water including curcumin, carmine, and dianthrimide. But, in these methods an evaporation to dryness or a strong acid medium is required prior to color development. The spectrophotometric azomethine-H method has the advantage of being performed under moderate conditions and has been reported as sensitive and selective when compared to other common spectrophotometric methods for boron (7).

Since Turkey has the largest boron reserves around the world, boron contamination of surface and ground water is expected, which focused us to the boron content of mineral water. In this study boron concentrations of several mineral water samples were determined by using spectrophotometric azomethine-H method.

EXPERIMENTAL

Sampling

Eighteen bottled mineral water (all in glass) samples from different brands and sources were bought on market in Turkey and stored at room temperature. The origins of the mineral water samples were gathered from the label of each bottle. Numerical codes were given to the samples from 1 to 18 to keep the brand names anonymous.

Method

Ten mililiters of priorly degassed mineral water sample (adequately diluted if necessary) was taken to a PET bottle of 25 mL. Two and half mililiters of azomethine-H solution (1.0 g azomethine-H and 2.0 g ascorbic acid in 100 mL distilled water) and 2.5 mL of ammonium acetate buffer solution (375 mL glacial acetic acid and 21 g of EDTA disodium salt were added to a solution containing 730 mL NH_3, 552.5 mL glacial acetic acid and 220 mL of distilled water) were added (8). Samples were kept in dark for an hour and their absorbances were measured with a UV-vis spectrophotometer (Shimadzu UV-1601) at 415 nm. All analyses were made in quadruplet. All chemicals used were of analytical grade. No glassware was used to avoid contamination. The quantitative determinations were achived by using a calibration curve which was prepared using different concentrations of aqueous boric acid standard solutions.

RESULTS AND DISCUSSION

The origins of the mineral water samples collected and the results of boron analysis were given in Table 1. The results have shown that 9 of 18 mineral water samples (Sample no. 1, 3, 4, 7, 8, 11, 12, 13, 17) had a boron concentration that exceeded the recommended value of 2.4 mg/L by WHO.

Although the consumption of mineral water in Turkey is lower than in European countries, nowadays it shows an upward trend. The evidences of negative health effects of boron have been shown in various studies (9, 10). From this point of view, the results of this study indicate the need of a stricter boron concentration monitoring for the quality of the bottled mineral waters.

Table 1. Origins and boron concentrations of the mineral water samples.

Sample No	Origin	Boron (mg/L)
1	Afyonkarahisar	10.52±0.013
2	Beypazarı, Ankara	0.83±0.005
3	Kızılcahamam, Ankara	3.58±0.011
4	Edremit, Balıkesir	3.75±0.011
5	Akkaya, Bolu	0.34±0.002
6	Gökçebağ, Burdur	0.35±0.013
7	Uludağ, Bursa	2.57±0.018
8	Uludağ, Bursa	3.33±0.033
9	İnegöl, Bursa	0.13±0.012
10	Uludağ, Bursa	1.25±0.002
11	Uludağ, Bursa	2.78±0.007
12	Kınık, Bursa	3.28±0.026
13	Bursa	5.62±0.011
14	Eskipazar, Karabük	2.17±0.016
15	Alaşehir Manisa	1.33±0.017
16	Kula, Manisa	0.23±0.003
17	Kula, Manisa	2.55±0.022
18	Salihli, Manisa	<0.1

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