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Examining the Microbial Quality and Trace Elements of Bottled Water Available in Mashhad Stores

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ABSTRACT

Background: The consumption of bottled mineral water has increased significantly in recent years. This water has certain features that can affect human health. In this study bottled water is examined in terms of its conformity with standard criteria such as physical, chemical, microbial characteristics and hardness of bottled water.

Materials and methods: Our study conducted on 9 kinds of bottled mineral water in Mashhad in 2015 and seven chemical, physical, and microbial characteristics are examined. The mean values of each attribute were compared with the amount listed on the sample label using standard criteria.

Results: The results indicated that the bottled waters do not have microbial contamination. However, according to the results, the amount of fluoride in all samples is lower than the standard and in 4.8% of the samples the nitrate content is higher than the standard.

Conclusion: The results showed that the level of toxic metals is lower than the standard and the recommended values and therefore the consumption of such water does not threaten the consumers' health.

Keywords: Quality, Bottled water, Traces metals, Mashhad

INTRODUCTION

In areas where there is not drinking water with good quality nor is it possible to treat water, the use of bottled water is a good alternative. Therefore, the consumption of bottled water in different parts of the world due to popular demand for safe, clean, and fresh water has grown considerably [1]. Today, bottled water is consumed in many places due to ease of access, relatively low cost, better taste, and low level of impurities. Water is one of the necessary elements for life and an important source of trace elements intake in human body. However, its quality has a great impact on one's health. Trace elements can be classified into essential elements for human life, such as chromium, cobalt, copper, iron, manganese, molybdenum, selenium and zinc, and potentially toxic elements such as silver, aluminum, arsenic, cadmium, lead and nickel [2-4]. A large number of mineral compounds, especially metal ions have a dual role in humans, so that some are essential for humans, while most of them are poisonous at high concentrations [5]. Recently, people around the world have great tendencies to use bottled mineral water for different reasons [6-8]. European countries are the main consumers of water at present, but the increasing trend of consumption is faster in Asia and the Pacific, so that the increase is reported to be 15% [6]. According to the standards of Iran, natural mineral water is the water which is determined by its special minerals and trace elements and other compounds. Its compounds are stable in different seasons and the amount of its salt is standard [9]. Bottled mineral water can affect human health due to having a set of chemical elements such as the ions of potassium

[10] nitrate [11] fluoride [10,12] and magnesium [13]. As the consumption of bottled water increases, it is very essential to carry out continuous research on water quality. In 2006, 17 kinds of bottled water were examined in Hamadan and it was concluded that there was a difference between the amounts of nitrate, sulfate, chloride and magnesium and other minerals of the water and the amount listed on their label. Moreover, the amount of calcium and pH was higher than the standard level in Iran and the world [14]. The bottled water produced by different factories in Tehran was examined and it was concluded that the rate of nitrate in bottled water was at the standard level [15]. In another research conducted on the most popular bottled water in Tehran bacteriological contamination was found in half of them [16]. The results of the research conducted on the microbial-chemical quality of bottled water in Birjand in 2006 showed that in 100% of cases the rate of sodium and potassium and in 53% of cases the rate of nitrate were out of the standard level [17]. In another examination on the bottled water of 41 countries of the world in the Netherlands and their comparison with the standards of this country showed that the water was similar to drinking water in terms of its healing properties, but its hardness was more than the drinking water [10]. This study aims to investigate the quality of bottled water in Mashhad according to the available standards in terms of physical, chemical, and microbial properties and pH as well as other trace elements.

MATERIALS AND METHODS

This cross-sectional study on the bottled water in Mashhad in terms of the concentration of toxic trace metals was conducted in autumn 2015, by testing 9 highly-consumed brands of 1.5-liter bottled water. The samples were taken randomly from different brands of bottled water. Due to the fact that different urban areas might be different in terms of having various kinds of bottled water, the samples were selected from all urban areas. In this study, by going to the supermarkets which were randomly selected from different parts of the city it turned out that the mineral waters had no production date and it was not known when the bottles had been filled up. Since the study was a general survey and comparison of bottled water available to the individuals, in order to enter the bottles in the study no particular terms or conditions were taken into account. In total, 9 kinds of bottled water were purchased and after the necessary measurements, the mean was calculated and compared with the standards. Chemicals characteristics including pH (PH meter HANNA-PH209), TDS (total dissolved solids) EC (electrical conductivity), alkalinity, calcium and magnesium (titrimetric method) fluoride and nitrate (using a spectrophotometer) were measured in the laboratory. The mean of each parameter was calculated [17] and compared with bottled water and drinking water standards [9]. Moreover, the rate of trace elements with maximum allowance [12-20] was investigated.

RESULTS

The results showed that none of the samples had physical or microbial contamination. The fluoride content in the analyzed samples was lower than the standards for drinking and mineral water. The study showed that in 6% of the cases, the amount of nitrate was more than the recommended limit (Desani bottled water had the highest millimeter per liter of nitrogen). The results showed that the measured value for magnesium was different from the printed value on the bottle label (Tables 1-7).

Table 1: The amount of TDS in the tested water

Name water characteristics	Damavand	Vota	Alis	Koh rang	Koh dasht	Zamzam	Desani	Bishe	Polor
Measured values (mg/l)	189	40.5	229	276.5	134	412	200.5	225	76.3
Tag values (mg/l)	-	-	-	-	-	180	243	-	-
The difference between the measured values with the label (%)	-	-	-	-	-	-100	17	-	-
WHO (world Health Organization)	1000	1000	1000	1000	1000	1000	1000	1000	1000
IBWA (international Bottled Water Association)	500	500	500	500	500	500	500	500	500

Table 2: The amount of alkalinity in the tested water

Name water Characteristics	Damavand	Vota	Alis	Koh rang	Koh dasht	Zamzam	Desani	Bishe	Polor
Measured values (mg/l)	123	99.3	75	202	139	260	142.5	200	143
Tag values (mg/l)	212	29	-	260	120	-	40	200	65
The difference between the measured values with the label (%)	41	<-100	-	22	-15	-	<-100	0	<-100
WHO (world Health Organization)	-	-	-	-	-	-	-	-	-
IBWA (international Bottled Water Association)	-	-	-	-	-	-	-	-	-

Table 3: The amount of nitrate in the tested water

Name water characteristics	Damavand	Vota	Alis	Koh rang	Koh dasht	Zamzam	Desani	Bishe	Polor
Measured values (mg/l)	0	0	0	0	0.52	5	17*	0	0
Tag values (mg/l)	7.5	2.3	-	4	0.5	-	10	6.1	5
The difference between the measured values with the label (%)	100	100	-	100	-4	-	70	-	-
WHO (world Health Organization)	10	10	10	10	10	10	10	10	10
IBWA (international Bottled Water Association)	10	10	10	10	10	10	10	10	10

Table 4: pH value of the tested water

Name water characteristics	Damavand	Vota	Alis	Koh rang	Koh dasht	Zamzam	Desani	Bishe	Polor
Measured values (mg/l)	0	7.2	7.9	7.9	7.6	7.9	7.9	8	7.8
Tag values (mg/l)	7.5	7	7.8	7.6	7.35	7.03	6.8	7.06	7.4
The difference between the measured values with the label (%)	-	-	-	-	-	-	-	-	-
WHO (world Health Organization)	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8
IBWA (international Bottled Water Association)	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8	6.5-8

Table 5: The amount of fluoride in the tested water

Name water characteristics	Damavand	Vota	Alis	Koh rang	Koh dasht	Zamzam	Desani	Bishe	Polor
Measured values (mg/l)	0.2	0.21	0.3	0.21	0.4	0.1	0.2	0.21	0.21
Tag values (mg/l)	0.2	0.11	-	0.23	0.09	-	0.23	0.07	0.07
The difference between the measured values with the label (%)	0	95	-100	86	<-100	-	-	-100	-100
WHO (world Health Organization)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
IBWA (international Bottled Water Association)	4	4	4	4	4	4	4	4	4

Table 6: The amount of calcium in the tested water

Name water characteristics	Damavand	Vota	Alis	Koh rang	Koh dasht	Zamzam	Desani	Bishe	Polor
Measured values (mg/l)	57.1	6.9	40	46	105	100	63	38.2	15.4
Tag values (mg/l)	56.4	9.8	56	62	40	45	14	71	32
The difference between the measured values with the label (%)	-76	29	28	25	-100	-100	<-100	46	51
WHO (world Health Organization)	-	-	-	-	-	-	-	-	-
IBWA (international Bottled Water Association)	-	-	-	-	-	-	-	-	-

Table 7: The amount of magnesium in the tested water

Name water characteristics	Damavand	Vota	Alis	Koh rang	Koh dasht	Zamzam	Desani	Bishe	Polor
Measured values (mg/l)	5.6	3	4	7.8	13.6	26.2	17.6	6.4	4.2
Tag values (mg/l)	15.4	2.3	13.15	20	7	10	27	13.3	7.6
The difference between the measured values with the label (%)	63	-30	69	61	94	-100	34	51	44
WHO (world Health Organization)	50	50	50	50	50	50	50	50	50
IBWA (international Bottled Water Association)	-	-	-	-	-	-	-	-	-

DISCUSSION

The results showed that none of the samples had physical, chemical or microbial contamination. In the study of bottled water conducted by Malekpour in Tehran [16], microbial contamination was found. There was a difference between the values of fluoride and nitrate ions and the standard value. According to the World Health Organization, the use of fluoride in the water, edible salt, as well as the use of toothpaste containing fluoride and adding milk to the diet are recommended. However, as the fluoridation of water has a special technique that may not be accepted by people, it is recommended to use other methods than water fluoridation in

developing countries [21]. Considering the growing trend of consumption of bottled water, monitoring and controlling water quality are very important in terms of public hygiene and community health.

CONCLUSION

The consumption of bottled water is increasing continuously and therefore it is important to evaluate its quality. In most cases, the elements in the studied samples were consistent with the standards, but in a few of the cases the elements were inconsistent with the standards. The higher concentration of some of the ions (nitrate) than the hygienic rate allowed, which can affect the health of community particularly the health of vulnerable people, should be investigated by the authorities and administrators. Meanwhile, the respected producers should be required to observe the relevant standard more carefully while labeling and indicate the points such as manufacturing and expiry dates and the storage conditions on the label.

CONFLICT OF INTEREST

None of the authors has a conflict of interest to disclose.

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