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EVALUATION ON BOTTLED NATURAL MINERAL WATER

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ABSTRACT

Introduction

Natural mineral waters are formed during water cycle. It has a certain mineral content and an unchanging basic chemical composition. There are drinking and mineral water sources in Turkey. Mineral concentrations of water resources are very high and consumption is becoming increasingly popular. Constituents, naturally present in natural mineral waters, maximum limits and general characteristics are specified in the Turkish Official Gazette in accordance with the European Community directives.

Aim of the study

The aim of this study is to examine bottled mineral waters sold in Erzurum.

Material and methods

Bottled mineral waters were purchased from various places in Erzurum market in January, 2017. Samples are numbered. Constituents on the sample's label were examined and evaluated.

Results

Range of Fluoride, Chloride, Sulphate, bicarbonate, sodium, potassium, calcium, magnesium were found 0.01-1.4 5.05-189, 4.42-138, 56-1865, 17.55-425, 3.18-393.2, 29.98-393.2, 10.5-111 mg/l in samples, respectively.

Conclusions

Information on bottle label of examined natural mineral water concurs with Turkish natural mineral water regulations. Contains generally rich mineral salts, bicarbonate, calcium, magnesium. When the results of studies about natural mineral waters in the world and in our country are compared, natural mineral waters in our country is rich in terms of mineral salts. Despite the increasing consumption of natural mineral water, it is well below world consumption.

Key words: natural mineral water, chemical quality, Erzurum

INTRODUCTION

Natural mineral waters and spring waters are formed by mixing meteorological waters with magma waters at different rates during water cycle (1).

Natural mineral waters are protected from any contamination affecting its quality. It has a certain mineral content and an unchanging basic chemical composition. The consumption of bottled mineral waters have increased greatly during the past few years, worldwide (3,4).

Turkey is geographically located on the Alpine-Himalayan organic belt where continuing tectonic activities are observed. There are drinking and mineral water sources. Mineral concentrations of water resources are very high and consumption is becoming increasingly popular (5, 6). Sales have increased rapidly. While the consumption of mineral water per capita in 1990 was 200 milliliters, it increased by 6.5 liters in 2010 (1, 6, 7).

When the water required for the body is taken as natural mineral water, a healthy water metabolism can be sustained (4), some of the daily required minerals can be taken, and positive effects on some functional disorders such as heartburn and kidney stone formation can be seen (8). Drinking water can be an important source of calcium, magnesium, sodium, because these minerals are highly bioavailable in water (9, 10).

The beneficial effects of natural mineral water on bone metabolism are linked to calcium contents (reduces bone resorption in calcium and estrogen insufficiency) and alkalinity (increases bone mineral density). In terms of bioavailability, calcium-rich mineral waters are similar to or better than dairy products. Therefore it can be an alternative to dairy products (11, 3). While calcium in the body plays an important role in myocardial activity, blood clotting, nerve conduction, in regulation of muscle contraction, regulation of cell (4), calcium deficiency in the body is very effective in the formation of important diseases such as hypertension and osteoporosis and osteomalacia (10).

Since hard water is less corrosive than soft water, it is considered that harmful substances such as lead, copper and cadmium are found to be less in hard water. Calcium in water can be protective here, and at the same time calcium prevents the absorption of these harmful ions from the intestines (10).

Magnesium in natural mineral water is important in bone formation, nerve and muscle activity, fat metabolism, glycolysis, ATP metabolism and protein synthesis (4, 10). It is responsible for the transportation of elements such as calcium, potassium and sodium along the cell membrane (10). As the Magnesium in the water increases, mortality is reduced to (12), arising from ischemic heart diseases for men.

There research is much that hard water with a high content of calcium and magnesium is protective against deaths from diseases like colon, rectum, pancreas, liver, breast, over cancer (10).

As the water hardness increases statistically, death from cardiovascular diseases decreases for both women and men (12).

Sodium in natural mineral water is important in regulation of cell permeability and body fluids (4).

Potassium in natural mineral water is important for muscle and myocardial activities, neuromuscular excitability, acid-base balance, water retention and osmotic pressure (4).

Sulphate in natural mineral water is important for Essential amino acids, cartilage, hair and nails formation, enzyme activity in redox processes and cellular respiration, intestinal peristalsis (4).

Fluoride in natural mineral water is important for protection and prevention of tooth decay, bone development (4).

Chloride in natural mineral water is important for the formation of the fluid required for the digestive process, balance of intestine, bile ducts and liver, laxative effect (4).

Bicarbonate in natural mineral water is important for digestive system because it neutralizes gastric acidity (4).It has a positive effect on bone metabolism (11).

Natural mineral water is characterized by bacterial micro flora, chemical and physical compositions. Natural mineral water should present risk-free features concerning consumers' health. The processes of water collection, processing, and bottling must comply with all the sanitary regulations, and the handling processes (collection, storage, filtration, and transportation) must not

alter its original composition (13). If undesirable pollution occurs in natural mineral water, bacteria that are dangerous for human health can be produced in this water.

Microbiological quality characteristics of bottled water are defined as “total coliform, fecal coliform, *Escherichia coli*, *Enterococcus spp.*, *Pseudomonas aeruginosa*, fecal Streptococci should not be detected in 250 ml bottled water” in Turkish natural mineral water regulations (Turkish Official Gazette 2004) (7, 14, 15).

Constituents naturally present in natural mineral waters, maximum limits and general characteristics are specified in the Turkish Official Gazette in accordance with the European Community directives (Table 1, 2, 3, 4, 5) (15).

Table 1. Indications and Criteria(15)

Indications	Criteria
Rich in mineral salts	Mineral salt content, calculated as a fixed residue, greater than 1 500 mg/l
Low mineral content	Mineral salt content, calculated as a fixed residue, not greater than 500 mg/l
Very low mineral content	Mineral salt content, calculated as a fixed residue, not greater than 50 mg/l
Contains bicarbonate	Bicarbonate content greater than 600 mg/l
Contains sulphate	Sulphate content greater than 200 mg/l
Contains chloride	Chloride content greater than 200 mg/l
Contains calcium	Calcium content greater than 150 mg/l
Contains magnesium	Magnesium content greater than 50 mg/l
Contains iron	Bivalent iron content greater than 1 mg
Contains fluoride	Fluoride content greater than 1 mg/l
Contains sodium	Sodium content greater than 200 mg/l
Suitable for a low-sodium diet	Sodium content less than 20 mg/l
Acidic	Free carbon dioxide content greater than 250 mg/l

Table 2. Constituents naturally present in natural mineral waters and maximum limits (15, 16, 2)

Constituents	Maximum limits (mg/L)		
	(Turkish natural mineral water regulations 2004)(15)	Commission Directive 2009/54/EC(16)	Codex Standard 108-1981(2)
Antimony	0.005	0.005	0.005
Arsenic	0.01	0.01	0.01
Copper	1	1	1
Barium	1	1	0.7
Boron			Borat 5
Mercury	0.001	0.001	0.001
Fluorides	5	5	
Cadmium	0.003	0.003	0.003
Chromium	0.05	0.05	0.05
Lead	0.01	0.01	0.01
Manganese	0.5	0.5	0.4
Nickel	0.02	0.02	0.02
Nitrates	50	50	50
Nitrites	0.1	0.1	0.1
Selenium	0.01	0.01	0.01
Cyanide	0.07	0.07	0.07
The amount of oxygen consumption for the organic substance	5		
Pesticides and similar substances	0.0001		
Polycyclic aromatic hydrocarbons	0.0002	0.0001	

Table 3. Criteria for Microbiological Analyses (15-17)

Parameter	Maximum limits (mg/l)		
	Turkish natural mineral water regulations (Turkish Official Gazette 2004) (15)	Commission Directive 2009/54/EC(16)	CAC/RCP 33-1985(17)
Parasites and pathogenic micro-organisms,	Water must be free	Water must be free	It will not present a risk to the health of the consumer
<i>E. coli</i> , other coliforms and faecal streptococci,	0/250 ml	0/250 ml	0/250 ml
Sulphite –reducing anaerobes,	0/50 ml	0/50 ml	0/50 ml
<i>Pseudomonas aeruginosa</i>	0/250 ml	0/250 ml	0/250 ml

Table 4. Organoleptic Properties (15, 16, 2)

Parameter	Maximum limits (mg/l)		
	Turkish natural mineral water regulations (Turkish Official Gazette 2004) (15)	Commission Directive 2009/54/EC(16)	Codex Standard 108-1981(2)
Organoleptic	No defect	No defect	

The aim of this study is to examine the labels of mineral waters sold in Erzurum, to classify and evaluate their quality properties.

MATERIALS AND METHOD

Bottled mineral waters were purchased from various places in Erzurum market in January, 2017. Samples are numbered. Cations, anions and total mineral content on the sample's label were examined and evaluated.

Statistical analysis

The mean value, median value of the parameters on the sample's label were calculated. The lowest and highest values were shown.

RESULTS

Bottled natural mineral waters examined in our study and their properties are shown in Table 5.

Table 5. Bottled natural mineral waters and their properties(mg/L)

Sample number	Fluoride	Bicarbonate	Chloride	Sulphate	Calcium	Magnesium	Potassium	Sodium	Water type
1	0,54	1383	5,05	9,52	393,2	28,8	393,2	22,2	Rich in mineral salts
2	0,46	1865	25,77	138	235	108	63	265	Rich in mineral salts
3	0,26	1400	40,7	22,6	288	36	8,23	40,04	Rich in mineral salts Ca-HCO ₃
4	0,05	56	6,92	50,35	29,98	59,97	3,18	17,55	Mg
5	0,01	1317	123	4,42	40,5	317	4,47	108,9	Rich in mineral salts Ca-Mg-HCO ₃
6	0,013	622	189	62,9	35	10,5	13,3	356	Rich in mineral salts Na
7	0,53	829	10,2	80	234	55	17	38	Ca-Mg-HCO ₃
8	1,4	1634	166	6	326	111	53	425	Rich in mineral salts F-Na- Ca-Mg-HCO ₃
9	1,04	1281	55	18,34	153	78,7	28,2	185	Rich in mineral salts

Fundamental statistical parameters of bottled mineral water are shown in Table 6.

Table 6. Fundamental statistical parameters of bottled mineral water (mg/L)

Variable	Statistical property			
	Minimum	Maximum	Range	Mean
Fluoride	0,01	1,4	1,39	0,48
Bicarbonate	56	1865	1809	1154
Chloride	5,05	189	183,95	69,1
Sulphate	9,52	62,9	53,38	43,6
Calcium	29,9	393	363,2	192,7
Magnesium	10,5	317	306,5	89,4
Potassium	3,18	393	390,02	64,8
Sodium	17,55	425	407,45	162

DISCUSSION

Zhang et al. examined that evolution process of natural mineral waters in Jingyu City (China) between 2011 and 2015. The results showed that the water type of some springs changed from Ca-HCO₃ face to Ca-Mg-HCO₃ face, and the other springs kept the category with Ca-Mg-HCO₃ face. Annual average Ca and HCO₃ concentration in natural mineral water found 20.75 mg/L and 116.56 mg/L (18).

Our country's mineral waters generally contain Na-HCO₃. There are also mineral waters containing Ca-HCO₃ Mg-HCO₃ and NaSO₄ (19). Calcium and bicarbonate contents of mineral waters examined in this study are considerably higher than mineral waters of Jingyu city

Caetano et al examined results of analysis of natural mineral waters in Portugal between 1915 and 2015. They reported that concentrations of chloride, sulphate, calcium, magnesium potassium and sodium of mineral water issuing from a natural spring were 48, 7.07, <10, 1.79, 4.2, 53.5 mg/L in 2014 (20).

Mean values of mineral waters examined in this study are higher than mineral waters of Portugal Wynn et al. studied 150 mineral waters collected from European countries and 40 mineral waters collected from North America and analysed chloride sulphate calcium, magnesium, potassium, sodium and bicarbonate in the samples. In European countries and North America, average concentrations were found 73, 260, 179, 39, 10, 120, 611 mg / L and 33, 131, 59, 17, 3-5, 63, 201 mg/L, respectively (3).

When the average values of mineral waters are compared; the average chlorine and sulphate values of European mineral waters and the average sulphate values of North American mineral waters are higher than the mineral waters examined in our study. In terms of other minerals (calcium, magnesium, potassium, sodium and bicarbonate), average values of the mineral waters examined in our study are higher than those of European and North American mineral waters.

Andrea et al studied chemical composition of 21 bottled natural mineral waters available on the Romanian market. Range of fluoride, chloride, sulphate, bicarbonate, sodium, potassium, calcium, magnesium were found <0.01-0.38, 0.12-118, 1.20- 36.7, 49-1806, 0.59- 140, 0.39-33.4, 9.66-326, 1.73-77.6 mg/l in samples, respectively. They reported that all samples were low mineral content except for one, and were carbonated. The sodium content did not exceed 20 mg/L in samples. Most of the samples were Ca-HCO₃, two samples were Ca-Na-HCO₃ (21)

While samples examined in this study are generally low mineral content, samples examined in our study are rich mineral content.

Astel et al studied 47 bottled mineral waters collected from supermarkets in Poland and analysed fluoride, chloride, sulphate, sodium, potassium, magnesium, calcium in the samples. Average concentrations were found 0.3, 41.8, 26.7, 34.7, 5.0, 23.1, 80.1 mg/L, respectively. They reported that label composition differ from measured composition (14).

Mean values of mineral waters examined in our study are higher than mineral waters of Poland. CRPCIS Institute in Romania published a report about mineral water in 2012. This report highlights these major findings: Per capita mineral water consumption in Romania rose from 7L/year in 1990 to 40L/year in 2010. Natural mineral water in Romania are generally bicarbonated, contained chloride, sulphate, calcium, sodium, magnesium minerals (22).

When per capita mineral water consumption in 2010 is compared; Consumption in Romania is higher than Turkey.

Azoulay et al. examined previous studies and published data on bottled mineral water in North America. They reported that range of calcium, magnesium, sodium were 3-310, 1-130, 36-1095 mg/l in samples, respectively (9).

When the average values of mineral waters are compared. Calcium and magnesium values of mineral waters examined in our study are higher than North American mineral water, but sodium value is lower than that of North America.

Van der Aa examined the bottle labels of 291 mineral waters from 41 countries. 10-20% of mineral waters exceed WHO and Dutch drinking water standards in terms of calcium, magnesium, potassium, sodium, sulphate and fluoride concentration. 4-9% of mineral waters exceed chloride standards. Most mineral waters were 'low mineral concentration' (TDS 50-500 mg/L) according to

the EU mineral waters directive. Various classification systems showed that most of the mineral waters could be characterized as calcium-rich, fresh water (23).

Mineral waters examined in our study comply with Turkish natural mineral water regulations, WHO and Dutch drinking water standards and have high mineral concentration' (TDS >1500 mg/L).

CONCLUSIONS

Natural mineral waters collected from Erzurum market, bottle labels, information on label were examined in our study.

Natural mineral water;

- Information on bottle label concur with Turkish natural mineral water regulations
- Selling with 250 ml glass bottles or packages.
- Easily findable in supermarket, restaurant, petrol station, cafe, school cafeteria etc. Bottled products is safe
- Contains generally rich mineral salts, bicarbonate, calcium, magnesium.
- While there are Fluoride, bicarbonate, chloride, sulphate, calcium, magnesium, potassium, sodium(mg/L) on bottle label of all samples, there are aluminium, iron, silicate, phosphate and ammonium values (mg/L) on bottle label of some samples also.
- Samples originate from different source in our country.
- When the results of studies about natural mineral waters in the world are compared, natural mineral waters in our country have rich in mineral salts.
- Despite the increasing consumption of natural mineral water, it is well below world consumption.

The main reasons for low consumption of natural mineral water in Turkey are packaging, lack of information, not adapting to technological developments. In recent years, the production of irreversible bottles, selling 6 bottles / packs , natural mineral water with fruit flavor increased consumption(6).

Natural mineral water is safety and positive effects on health and good alternative to tap water and spring water for daily consumption (1).

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