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Physico- Chemical, Microbiological and Sensory Properties of Some Commercial Bottled Drinking Water In Egypt.

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Abstract

Bottled water like any drinking water used for human consumption should be safe and of standard quality to ensure adequate public health significance**.** But, the quality of bottled water used for human consumption is not subjected to any stringent quality control measure in Egypt. People buy bottled water for a variety of reasons, including convenience, fashion, and taste or because they think it is safer than tap water. The taste of the water has to do with the way it is treated and the quality of its source, including its natural mineral content. However, taste does not always indicate safeness. The samples were collected by random sampling technique. To asses the quality of bottled water in Al-Qalyubia, Egypt. The present study was carried out to determine the physicochemical, microbiological, sensory quality parameters and the concentration of heavy elements of six brands of bottled drinking water available in Al- Qalyubia and to compare with drinking water guidelines set by the WHO and the Egyptian Standard for bottled water(EOS). The results obtained showed that the physicochemical, microbiological and sensory parameters as well as the concentration of heavy elements in almost all the bottled drinking water were below the permissible limit set by WHO and Egyptian Standard (EOS). Hence, all the tested bottled water samples are safe for drinking purpose.

.**Keywords**: Bottled drinking water, physicochemical parameters, microbiological examination.

Introduction

Water is believed to be lifeline. It is an essential component for life on earth, which contains minerals extremely important in human nutrition **(Versari *et al*., 2002 and Brima, 2017).**

An average man (with 50 kg-60 kg body weight) requires about 3 litres of water in liquid and food daily to keep himself healthy. It is also a useful resource for domestic, industrial and agricultural purposes **(Onweluzo and Akuagbazie,2010 and Versari *et al*.,2002).**

According to World Health Organization (WHO), mortality caused by water associated diseases is more than 5 million per year **(WHO, 2013).** Access to a high quality water is required for drinking purposes has improved over the last decades in almost every part of the world. However, nearly one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation **(Cabral, 2010).**

The supply of safe potable water has a significant impact on the prevention of water transmissible diseases (**Altin *et al*., 2009** and **Al-Kalbani *et al*., 2017)**.The abundance of organic compounds,toxic chemicals, radionuclides, nitrites, and nitrates in potable water may cause adverse effects on the human health **(Demirak *et al*., 2006 and Nadaraja *et al.*, 2015).** Therefore, it is essential to constantly monitor water quality used for drinking purposes **(Doria *et al*., 2009; Gupta & Kumar, 2012 & Kumar and Bahadur, 2013).** Bottled water is defined as water that is intended for human consumption and that is sealed in bottles or other containers, which has no added ingredients, except that it may optionally contain safe and suitable antimicrobial agents **(Semerjian,2011).**

The global Bottled Water Industry has become a multibillion dollar industry. There has been a remarkable growth which has been trajectory for the sector. The usage of bottled water in the world is mainly in North America (30%), Europe (29%), Asia (27%), and other parts of the world (14%) and people from all over the world drink about $13x10^{10}$ litres of bottled water annually **(Gangil *et al*.,2013; Khatoon and Pirzada,2010; Raj,2005; Rani *et al*.,2012).**

The brand giants of the global bottled water market include mainly Danone with Evian and Volvic, Nestlé with pure Life, Poland Spring, Perrier and San Pellegrino, Coca-Cola with Bonanqua and Kinley, Dasani and Ceil and PepsiCo with Aquafina, Aqua Minerale and Aqua Diamant **(Rani *et al*.,2012).**

Bottled water consumption is estimated to be about 3.8 liters per person. Bottled water in Egypt is basically purified water obtained from different locations in the country**(The World's Water, 2007).**

It is against this background that, the paper is aimed at collecting some samples of bottle water sold within Qalyubia Governorate, assessing its physicochemical, microbiological and sensory quality and comparing the result with some national and international standard through survey design and laboratory experiment.

Materials and Methods

3.1. Materials:

3.1.1. Bottled water sampling:

Six different brands of the most popular bottled water: Aquafina; Baraka;Dasani, Safi, Haya and Nestle were purchased from local markets in Egypt during the summer of 2019. Sampling occurred between July 2019 and September 2019. At least 10 brands within their validity period and in the same size (1.5 l PET bottles) were purchased.

3.1.2. Tap water samples:

Randomly collected from four different locations in Al- Qaliobia , Egypt.

3.2. Methods:

3.2.1 Sampling:

Bottle water of different brands was transported immediately in an ice box for analysis. The collected samples were analyzed in the holding company for drinking and wastewater laboratory in Qaliobia and the laboratory of Faculty of Agriculture, Benha University, Egypt, within 1 h. All bottles were kept sealed and refrigerated at 4°C±1 until the time of analysis. Tap water samples were randomly collected from three different locations in Al- Qaliobia, Egypt .Three replicates of 2 L each were collected from tap water faucets that were left running for at least 5 min before collecting the samples. Samples were collected also from the same locations from taps equipped with charcoal liters. Tap water was kept in sealed glass bottles, refrigerated and transferred to the laboratory for analysis. The results obtained were compared with the Egyptian Standard for bottled water **(EOS, 2005)** and Food and Drug Administration **(FDA, 2012)** . Physicochemical ,microbiological and sensory analysis for all brands was analyzed according to the Standard Methods for Examination of Water and Wastewater Waste water **(APHA, 2012).** The selected metals and heavy metals were determined using Atomic Absorption Spectrophotometer, Shimadzu model (AA-6650); Shimadzu Corporation, Kyoto, Japan.

The present study was carried out on a total of 6 commercial brands of uncarbonated natural bottled water produced in Egypt and were designated.

The volumes of the bottles were 1500 mL. These bottles have a validity date of one year. Bottled water samples were collected, preserved, and analyzed physically, chemically, microbiology and sensory according to the Standard Methods for the Examination of Water and Wastewater **(Eaton *et al.*,1995).** Data were tabulated and analyzed using Statistical Package for Social Sciences (SPSS) version 11.0 computer software package **(Daniel, 1995).**

3.2.2. Physico-chemical parameters:

Standard methods of physicochemical analysis of water were used to collect; processed and analyzed the water samples using standard methods within 6 hours of collection**. (WHO, 2004 and APHA, 2005).** These include: temperature, pH, electrical conductivity, total dissolved solids, turbidity, magnesium, calcium, lead, copper, zinc, bicarbonate, chloride, nitrate and phosphate.

3.2.2.1. Determination of pH:

The pH of water samples was determined according to the method described by **(Udo *etal.*, 2009; Njosi, 2005)** using pH meter probe number HI 7662 (HI255) model. pH meter was switched on and was allowed to stabilize; it was then calibrated using buffer of 4 and 7 pH to ensure accurate reading after which the electrode of the meter was inserted into each of the sample and was allowed to stabilize for some seconds, However, the reading on the meter was recorded.

3.2.2.2. Determination of Electrical Conductivity:

Electrical conductivity was determined according to the method described by (**Udo *et al.*, 2009)** The meter was calibrated using standard potassium chloride solution after which the probe of the conductivity meter was suspended in air to Zero calibration. It was then immersed into the sample by taping the probe repeatedly to remove any trapped air bubble in the sleeve. The probe was allowed to stabilize and the reading on the meter was recorded according to the manufacturer's instruction in µs/cm.

3.2.2.3. Determination of Total Dissolved Solids (TDS):

Total dissolved solid (TDS) was determined according to the method described by **(Udo *et al.*, 2009)** with conductivity meter probe number HI 76310 (Hanna HI255) model. The meter was calibrated initially using standard potassium chloride solution and then the electrode of the meter was immersed in the sample. It was allowed to stabilize and the reading on the meter was recorded according to the manufacturer's instruction measured inmilligram per liter (mg/l).

3.2.2.4. Determination of Turbidity:

Turbidity of water sample was determined according to the method described by **Olajide (2012)** with digital turbidity meter HACH 2100N Model. The meter was switched on and was allowed to warm up for 10 minutes. 30ml of the sample was dispensed and transferred into the sample cell after which the turbidity of the sample was recorded.

3.2.2.5. Determination of Alkalinity:

Water sample (50ml) was taken and two drops of methyl orange were added then sample was titrated by H_2SO_4 (0.02N) until the color changed from yellow to pink then volume of H_2SO_4 was recorded **(Mihayo and Mkoma 2012).**

3.2.2.6. Determination of Total Hardness (TH):

Water sample (50ml) was placed in a 250 ml flask and 2ml of ammonium buffer solution and EBT indicator were added. It was titrated by standard EDTA(0.01 M) until color changed from wine red to blue then volume of EDTA was recorded and entered in the equation as :

Total hardness (ppm) as $CaCO_3$ = volume of EDTA (ml) × 1000/volume of sample (ml) according to **(APHA, 1999).**

3.2.2.9. Determination of Calcium (Ca^{++}):

Calcium was calculated using the equation reported by **(APHA, 1999)** as: Ca^{+2} (ppm)= 0.4 × calcium hardness (ppm)**.**

3.2.2.10. Determination of Magnesium (Mg^{++}):

Magnesium was calculated using the equation reported by **(APHA, 1999)** as: Mg^{+2} (ppm) = 0.24 × magnesium hardness (ppm).

3.2.2.11. Determination of Fluoride:

Fluoride was determined by Spectrophotometer (DR 2000) using spands reagent solution. The stored program number for fluoride (F^-) was entered. The wavelength dial was rotated until the small display show, F^- (mg/l). Sample cell was filled with 25ml of water sample, while the second sample cell (blank) was filled with 25 ml of distilled water. Then 5ml of spands reagent was added into each cell, after that each cell was mixed for one minute to accelerate the reaction. The blank was placed into the cell holder then the light shield was closed. After press zero button the display will shows F^- (0.00 mg/1). The prepared sample was placed into the cell holder and the light shield was closed and the results of F^- (mg/l) was recorded **(APHA, 1999).**

3.2.2.12. Determination of Sulphate:

Sulfate was determined by Spectrophotometer (DR2000) using sulfaver 4 powder pillows. The wavelength dial was rotated until the small display shows 450nm. The same fluoride previous steps were followed and result of SO_4^{-2} (mg/l) was recorded as described by **(APHA, 1999).**

3.2.2.13. Determination of Nitrite:

Nitrite was determined by Spectrophotometer (DR 2000) using ferrous sulfate powder pillows. The wavelength dial was rotated until the small display shows 585nm. The same previous steps of apparatus adjustment were followed and result of NO_2^- (mg/l) was recorded as described by **(APHA, 1999).**

3.2.2.14. Determination of Silica:

Silica was determined by Spectrophotometer (DR 2000) using silicomolybdate powder pillows. The wavelength dial was rotated until the small display shows 452nm. The same previous steps of apparatus adjustment were followed and result of SiO_2(mg/l) was recorded as described by **(APHA, 1999).**

3.2.2.15. Determination of Ferrous (Fe^{++}):

Ferrous was determined by Spectrophotometer (DR 2000) using 1.10 phenanthroline powder pillows. The wavelength dial was rotated until the small display shows 510nm. The same previous steps of apparatus adjustment were followed and result of Fe^{+2} (mg/l) was recorded as described by **(APHA, 1999).**

3.2.2.16. Determination of Manganese:

Manganese was determined by Spectrophotometer (DR 2000) using periodate oxidation powder pillows. The wavelength dial was rotated until the small display shows 525nm. The same previous steps of apparatus adjustment were followed and result of Mn^{+2} (mg/l) was recorded as described by **(APHA, 1999).**

3.2.2.17. Determination of Nitrate:

Nitrate concentration was determined according to the method described by **(Njosi, 2005)** using potable data logging spectrophotometer (DR/2010 HACH).The spectrophotometer was switched on and was adjusted to a wave length of 500nm frequency. One sachet of nitrate reagent powder was transferred into a small bottle designed for the nitrate analysis and 25ml of the water sample was mixed with the reagent in the tube and was placed in the spectrophotometer. The meter was allowed to stabilize after which the reading was taken and multiplied by 4.427 according to the manual instruction.

3.2.2.18. Determination of Phosphate:

Phosphate concentration was determined as described by **(Njosi, 2005)** using potable data logging Spectrophotometer (DR/2010 HACH) at a frequency wave length value of 890 nm. Twenty five milliliter (25ml) capacity bottle was filled up with the water sample and was mixed with the reagent powder and placed in the spectrophotometer according to the manual instruction and the reading was taken.

3.2.2.19. Determination of Chloride:

Chloride of water sample was determined according to the argentometric method described by **(Njosi, 2005)** 5ml to 20ml of the water sample was transferred into a conical flask and 2 to 3 drops of potassium chromate was added to obtain yellowish coloration. It was titrated with 0.1 molar silver nitrate solutions until the pink color end point was attained after which the record of the volume of titrate used was noted and recorded and the result was calculated using the following equation **(Skoog *et al.*,1996).**

Cl^- (ppm) = A × N × 35.45 × 1000/ volume of sample (ml).

Where:

A = volume of $AgNO_3$ (ml)

N =normality of standard $AgNO_3$

35.45 = Atomic mass of Cl^-

3.2.2.20. Determination of Bicarbonate:

Bicarbonate was determined according to the titrimetric method described by **(Njosi, 2005).** 10ml of sample was introduced into a conical flask and 2 to 3drops of phenolphthalein indicator were added. A color change in the water sample to a pink coloration indicated the presence of carbonate. The estimate of amount of carbonate was carried out by titration with 0.IM sulphuric acid to colorless neutralization point and the end point was noted and recorded. 2 drops of methyl orange indicator was added and titrated with same 0.IM acid, until a color change from orange to pink was obtained, and the final reading was recorded.

3.2.2.21. Elemental analysis

Sodium and potassium were determined by Flame Photometer. Iron, manganese were detected by Atomic Absorption (A.A.) Spectrophotometer in the acidified water sample using Instrumental Laboratories (1L), Model 551, equipped with a heated Graphite Atomizer Model (651) and deuterium arc background corrector. The procedure of samples preparation and analysis followed the method as described in **(APHA, 2005)** and by **(Abdel-Shafy, 2015).** Lead, calcium, magnesium, copper and zinc were determined according to the method of **(Njosi, 2005)** .125ml of the water sample was distilled in a beaker and was digested by putting on a hot plate and evaporated at a temperature of 350 ° C to a concentration of 25ml .The filter of the digest was allowed to cool. The digest was diluted up to 100ml volume with distilled water and was aspirated into an air acetylene flame of the Atomic Absorption Spectrophotometer Model 210VGP (AAS) The absorbance at auto zero set was read after the ready key display at an absorbance of 279.5nm for each sample. For example Zinc absorbance was read at a current of 2.0 ohms lamp.

Each result presented here is an average of 10 sequence readings on the Atomic Absorption (A.A) Spectrophotometer. These readings were correlated with a standard solution. Standards were purchased from the Instrumental Laboratories (1L). As control, a blank was made for each metal; using double distilled water, which was subjected to the chemical treatment and digestion similar to that of the examined samples.

3.2.3. Microbiological examination:

3.2.3.1. Preparation of samples for microbiological examination:

Detection of total yeast, fungi, and total vibrios were carried out using membrane filter technique. A 100ml of each type of bottled water samples were separately filtrated through a nitrocellulose membrane filter (0.45µm pore size and 47mm diameter). The membrane was transferred onto selective media (Candida agar, Malt yeast extract agar and Thiosulphate citrate bile salt sucrose agar, respectively). Yeast, *salmonellae* and total vibrios were detected and identified according to **El-Taweel and Shaban (2001)**. Detection and enumeration of sulphite reducing clostridia was carried out according **to Fewtrell *et al.* (1997).** Classical bacterial indicators such as total bacterial count, total coliform, faecal coliform and faecal streptococci were enumerated by using MPN methods according to **APHA (2005).**

3.2.3.2. Total viable bacterial count, molds and yeasts and coliform bacteria count:

One of the most common and frequent tests performed is the Coliform test. This is the bacteriological analysis of water, Coliform is an indicator for the presence of fecal matter and the potential presences of harmful disease causing pathogens.

A Coliform level of zero in drinking water is required or the water source is closed. The Most Probable Number (MPN) technique used for the microbiological testing.

3.2.3.3. Determination of Total Bacterial Count (TBC):

The bottled water samples (1ml) were placed in petri dishes. Sterile Molten plate count agar was added and dishes were rotated gently to ensure uniform mixing of the sample with agar. Dishes were inverted and incubated at 37º C /24hr.

3.2.3.4. Detection of *Escherichia coli* (*E.coli*):

A membrane filter a bosrbent pad was placed inside a sterile 60mm petri dishes. Molten endo broth medium was added to petri dishes. The water sample was filtered through amembrane filter which placed top side up on the pad using a rolling motion to avoid entrapping air bubbles. Dishes were inverted and incubated at 35±0.5º C /22-24hr.

3.2.4. Sensory evaluation of bottled water samples:

Bottled water samples were evaluated according to the method described by **AACC (2000).** A group of graduate students in Food Technology Department, Faculty of Agriculture, Moshtohor, Benha University. Bottled water samples and overall acceptability was calculated (100).

3.2.5. Statistical analysis:

ANOVA was carried out on data of all samples were applied the function of descriptive statistics "Excel" Software of Microsoft Office 2016. Least significant difference (L.S.D) analysis was adapted. Data are expressed as average ± standard error. according to **Gomez and Gomez (1999)**.

4. Results and Discussion:

4.1.Physico-chemical quality:

As presented in **Table (2)** all the samples tested, had turbidity values within the described limits by the Egyptian standards**(EOS, 2005)** (1.0 NTU), results which are similar to those found in New York **(NYSDOH, 2008).**

Total dissolved solids (TDS), or mineral content in drinking water, is acknowledged to be the major chemical factor affecting taste and likeability of drinking water when no off-flavors are present **(Burlingame *et al*., 2017).**

pH measurement is one of the most important and frequently used tests in water chemistry **(APHA, 2012).** In all bottled water brands, the pH values ranged between 7.55 and 8.04. These results are in agreement with the studies by **Abd El-Salam *et al.* (2008)**, **Ammar,(2003)**in Egypt, and **(Khan and Chohan, 2010)** in Riyadh, Saudi Arabia, as their results showed that pH values of bottled water brands were within the range of 6.5–8.5.

Electrical conductivity of water measures the capacity of water to conduct electrical current and it is directly related to the concentration of salts dissolved in water, and therefore to the (TDS)**(APHA, 2012).**

Conductivity of bottled water brands ranged between 254 and 333 µs/cm; these results are in agreement with the study by **Kadhim *et al.* (2018)**.

Results in **Table (2)** show that all bottled water samples of this study were in compliance with the Egyptian standard and World Health Organization (WHO) guideline for chloride (250 mg/L), where brands concentrations ranged between 10.60 and 101.5 mg/l. These results are in agreement with the studies by **Ibrahim *et al.* (2014), Saleh *et al.* (2008)**, and **Semerjian (2011)**, as they found that bottled water brands were in compliance with the chloride guidelines.

It was mentioned earlier that the mean concentration of total alkalinity ranged from 12.43 to 155 mg/L in Aquafina and Nestle, respectively **(Table 2).** these results are in agreement with findings obtained by **(Yilkal *et al.*,2019)** who found that the total alkalinity values ranged from (12 -165) mg/L.

The maximum concentration limit of total alkalinity described by **(WHO,2017)** and **(EOS,2005)** is 200 mg/L. In this study the value of total alkalinity in all the bottled drinking water was found below the permissible limit.

From the **Table (2)** it may be observed that the total hardness values of the bottled waters are found from 54 to 94 mg/L as CaCO3. Furthermore, **(Yilkal *et al.*,2019)** revealed that total hardness (TH) values were fluctuated between 4 mg/L to 97 mg/L as calcium carbonate in Bw20 and Bw4, respectively.

On the basis of the findings, it was concluded that the values of total hardness in all of the bottled water lie in permissible limits for drinking water (<500 mg/L) set by **(WHO, 2011).**

In this study, it could be noticed that the concentration of calcium hardness(as$CaCO_3$) concentration in the bottled water samples ranged from 20 to 74 mg/L in Aquafina and Dasani, respectively. On the other hand, the concentration of magnesium hardness(as$MgCO_3$) concentration in the bottled water samples ranged from 16 to 44 mg/L in Dasani and Aquafina, respectively as shown at **Table 2.**

The results in **Table (2)** showed that the highest value of ammonia concentration were recorded in Nestle water samples were(0.065 mg/l) while, the lowest value of ammonia concentration (0.015 mg/l)was noticed in Aquafina water samples. While, **Agbo *et al.* (2019)** found that ammonia values of tested bottled drinking water samples showed high amounts and ranged between 0.71 to 1.05 mg/L.

Table 2. The physico-chemical of parameters of some selected bottled water brands from Egypt .

Physico-chemical quality	**Brand**						
	Tap water	**Aquafina**	**Baraka**	**Dasani**	**Safi**	**Haya**	**Nestle**
pH	7.24±0.18	7.55±0.12	7.72±0.20	7.99 ±0.16	8.04 ±0.24	7.87±0.14	8.02±0.22
Turbidity(NTU)	0.33±0.02	0.17±0.01	0.56±0.02	0.18±0.009	0.88±0.03	0.32±0.03	1.00±0.04
Electrical Conductivity(µs/cm)	195±14.85	272±18.29	254 ±13.77	287 ±18.27	272 ±14.84	333±15.33	260 ±12.94
TDS(mg/L)	120±19.55	180 ±12.06	168 ±13.38	190 ±11.44	180 ±14.09	220±29.19	172±19.29
Chloride as Cl⁻(mg/L)	12.80 ±1.26	10.60 ±1.17	50.90 ±1.20	33.00±1.35	101.50 ±1.12	75.30±1.11	42.80±1.44
Alkalinity (mg/ L)	110.18±2.14	12.43±1.91	112.27±2.23	118.81±3.17	119.14±2.28	115.23±2.13	155.16±3.11
Total Hardness (mg/L)	100±0.42	64±0.07	94±0.12	90±0.23	54±0.17	84±0.13	75±0.19
Hardness(asCaCO3)(mg/L)	57±0.02	20±0.01	56±0.03	74±0.07	24±0.02	60±0.04	33±0.01
Hardness(asMgCO3) (mg/L)	43±0.13	44±0.29	38±0.22	16±0.12	30±0.11	24±0.09	42±0.07
Nitrite(µg/L)	0.010±0.001	0.03±0.001	0.05±0.002	0.11±0.001	0. 14±0.001	0.20±0.000	0.25±0.001
Ammonia(µg/L)	0.075±0.001	0.015±0.002	0.049±0.003	0.026±0.002	0.029±0.007	0.038±0.003	0.065±0.008

The concentration level of the cationic constituents present in the bottled water samples are: 1.5 to 16.23 mg/L for Sodium; 0.01 to 2.4 mg/L for Magnesium ; 13.02- 62.92 mg/L for Calcium; 8.5 -25.6 mg/L for Potassium **(Table 3).**

In this study, sodium concentration in the bottled water samples ranged from 1.5 to 16.23 mg/L in Aquafina and Nestle, respectively **(Table3)**. The concentration of sodium in all bottled water samples were below the **(WHO, 2017)** permissible limit. On the other hand, **Seda *et al.* (2013)** reported the mean concentration of sodium in Abyssinia, Aquaddis, and Aquasafe as 18.3 mg/L, 40.3 mg/L, and 23.2 mg/L, respectively. These reported concentrations of sodium in Aquaddis and Aquasafe were higher than the concentration of sodium found in this study and are also above the **(WHO, 2017)** recommendations.

It could be observed that the mean magnesium concentration in the bottled water sample ranged from 0.01 to 2.4 mg/L **(Table 3).** The lowest concentration of magnesium was found in Baraka while, the highest concentration of magnesium found in Dasani. According to investigation by **Mekonnen *et al.* (2015)** in different bottled waters in Gonder city, the mean concentration of magnesium ranged from 0.32 mg/L to 6.5 mg/L, however, relatively higher than our study.

Drinking calcium-poor water is considered dangerous for the risk for coronary diseases. An excess in calcium can alter the water taste. As shown in **Table (3)**, it is clear that despite the wide range of calcium levels in the collected samples (13.02- 62.92 mg/L), none exceeded the European Economic Community Council **(EECC, 1998)** guideline (100 mg/L). On the contrary, **Iliyasu *et al.* (2018)** mentioned that the mean calcium concentration in the bottled water sample was found in the range(124.40-175.98).

Table 3. Statistical analysis of major anions and cations in some brands of bottled drinking water from Egypt :

Element (units)	**Brand**						
	Tap water	**Aquafina**	**Baraka**	**Dasani**	**Safi**	**Haya**	**Nestle**
Sodium (mg/L)	10.8 ±3.64	1.5±5.79	15.91±4.42	8.16 ±19.95	14.02±22.87	**5.13±19.38**	16.23 ±13.33
Magnesium (mg/L)	2.851±0.45	0.4 ±0.68	0.01±0.31	2.4 ±0.79	1.8 ±0.27	**0.3±0.33**	1.5±0.27
Calcium (mg/L)	13.139 ±7.75	44.7373 ±0.97	29.2183±11.75	24.5803±1.43	13.0243±6.76	62.9213±3.61	50.7243±2.93
Potassium(mg/l)	29.802±0.74	10.6±0.53	25.6±0.52	20.9±0.82	8.5±0.16	16.397±0.55	12.6±0.86
Sulphate ($SO4^{-2}$)(mg/l)	13.1±0.15	12.1±0.11	12.2±0.17	12.6±0.09	11.5±0.13	13.6±0.11	11.4±0.08
Phosphate (mg/l)	0.10±0.04	0.12±0.03	0.15±0.01	0.18±0.07	0.13±0.07	0.39±0.01	0.11±0.05
Fluoride (F^-) (mg/l)	0.134±0.006	0.02±0.002	0.05±0.002	0.54±0.004	0.22±0.001	1.13±0.005	1.22±0.009
Nitrate (mg/L)	0.03±0.00	0.01±0.00	0.03±0.09	0.55±0.00	0.78±0.05	0.28±0.10	0.82±1.3

Potassium is an essential element in both plant and human nutrition and occurs in ground waters as a result of mineral dissolution, from decomposing plant material, and from agricultural runoff **(APHA,AWWA and WEF, 2012).**Potassium concentrations in bottled water brands ranged between 8.5 and 25.6 mg/l.

Microbiological evaluation of bottled water quality

According to the Egyptian standards No. 1589/2005**(EOS,2005).**54.8% of the examined bottles were bacteriologically unacceptable **(Table 5)**. Lower figures were obtained by **(ELBatouti, 2002)** who noticed that 38.3% of the examined bottled water samples in Alexandria/Egypt were bacteriologically unsatisfactory and failed to meet the Egyptian standards.

Table 5. Microbiological evaluation of bottled water quality

Type of water	Items					
	Total viable counts (CFU/1 mL)	**Yeast and molds (CFU/1 ml)**	**Total coliform counts (CFU/100 mL)**	***Escherichia coli*** **(CFU/100 mL)**	***Pseudomonas spp.*** **CFU/100ml**	***Clostridium perfringens*** **(sulfate reducing Clostridium) CFU/100ml**
Tap water	**10.75×10^1**	**ND**	**ND**	**ND**	**ND**	**ND**
Aquafina	**1.25×10^1**	**ND**	**ND**	**ND**	**ND**	**ND**
Baraka	**3.06×10^1**	**<10**	**ND**	**ND**	**ND**	**ND**
Dasni	**6.55×10^1**	**<10**	**ND**	**ND**	**ND**	**ND**
Safi	**2.75×10^1**	**12**	**ND**	**ND**	**ND**	**ND**
Haya	**2.35×10^1**	**<10**	**ND**	**ND**	**ND**	**ND**
Nestle	**8.75×10^1**	**15**	**ND**	**ND**	**ND**	**ND**

Table 6. Sensory evaluation of bottled water:

Type of water	Items			
	Color	**Taste**	**Odor**	**Overall**
Tap water	Colorless	**Acceptable**	**Odourless**	**Acceptable**
Aquafina	Colorless	**Acceptable**	**Odourless**	**Acceptable**
Baraka	Colorless	**Acceptable**	**Odourless**	**Acceptable**
Dasni	Colorless	**Acceptable**	**Odourless**	**Acceptable**
Safi	Colorless	**Acceptable**	**Odourless**	**Acceptable**
Haya	Colorless	**Acceptable**	**Odourless**	**Acceptable**
Nestle	Colorless	**Acceptable**	**Odourless**	**Acceptable**

It is necessary to estimate the acceptability or the organoleptic properties of the water used for drinking as it is an easy standard for used by the ordinary consumer on the domestic scale without using any devices or equipment.

Acceptance of the bottled water samples from the sensory side indicates that its chemical and physical properties are to a large extent acceptable or good, and from the results discussed in the **Table (6).**

Conclusions and Recommendations

All the tested domestic bottled water samples were analyzed for various physico-chemical as well as microbiological water quality parameters. Results showed a widespread in the characteristics of investigated bottled waters, yet the physicochemical, microbiological and sensory parameters as well as the concentration of heavy elements in almost all the bottled drinking water were below the permissible limit set by WHO and Egyptian Standard (EOS, 2005). The study covers a limited number of bottled waters contained in up to 10-L containers marketed in Egypt ; it is recommended that all marketed bottled waters be monitored for quality and identity and be licensed by concerned authorities to safeguard consumers' health.

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الخواص الفيزوكيميائية ،الميكروبيولوجية والحسية لبعض مياه الشرب المعبأة المتداولة تجارياً فى مصر

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تم دراسة تقييم جودة بعض نوعيات مياه الشرب المعبأة في محافظة القليوبية ،جمهورية مصر العربية، وفقا للخصائص الفيزيائية، الكيميائية ، الميكروبيولوجية والحسية حيث تم أختيارستة أنواع مياه معبأة من السوق المصرى وهى أكوافينا‘ بركة‘ داسانى‘ صافى‘ حياة و نستله بالاضافة لعينة الكنترول وهى مياه الصنبور الصالحة للشرب. تم تحليل العينات السبعة وكانت عينات المياه خالية من البكتريا المسببة للأمراض وخاصة بكتريا القولون. تركزت الدراسة الحالية على الخواص الطبيعية والكيميائية لبعض عينات مياه الشرب المعبأه الأكثر مبيعاً فى السوق المصرى. واوضحت نتائج التقييم الحسى لهذه العينات جميعها أن كل العينات مقبولة طبقاً للصفات الحسية تحت الأختبار. أشارت النتائج إلى أن متوسط القيم الفيزوكيميائية ، العناصرالمعدنية والمعادن الثقيله والأمان الميكروبيولوجى فى المياه المعبأه المصرية تحت الدراسة كانت ضمن المعايير المصرية ومنظمة الصحة العالمية مقارنة بالماء الخام لنهر النيل.

الكلمات المساعدة: المياه المعبأة – مياه الشرب –الخصائص الكيميائية والفيزيائية – الخصائص الميكروبيولوجية – الخصائص الحسية – مواصفات مياه الشرب المحلية والإقليمية والعالمية.