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Research article

A STUDY OF SOME PHYSICOCHEMICAL PARAMETERS OF PLASTIC BOTTLED DRINKING WATER FROM DIFFERENT SOURCES (MANUFACTURED BRANDS) IN KURDISTAN REGION-IRAQ.

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ABSTRACT: The analysis of some physicochemical parameters and the heavy metals of Cr, Co, Ni and Cu were carried out in samples of plastic bottled drinking water of Seven brands in Iraqi Kurdistan Region for a three sampling collection during November 2013 to May 2014. The analysis of different parameters namely; pH, turbidity, total hardness, dissolved oxygen (DO), chloride (Cl^-), calcium (Ca^{+2}) were carried out as per standard methods. The present study aimed to compare the measured results of the physicochemical properties of the bottled water with the reported results on the plastic bottles of the manufacturer's labeling brands and also to compare with the guideline value of World Health Organization (WHO). Furthermore, this study also objected to indicate the levels of these heavy metals (Cr, Co, Ni and Cu) content in the samples of the studied brands. The results obtained were found exceedence of WHO drinking water standard for Chromium & Nickel in Life, Alla, and Kani; exceedence for Nickel in OXAB and Hayat; even so they have not been reported on the label. Therefore, further studies are recommended; especially, analyses of microbiological tests, and also analysing more heavy metals.

Key words: Plastic, Drinking water, Iraq

INTRODUCTION

Of all the natural resources, water is unarguably the most essential and appreciated. Life began in water and spirit is natured by water. Water is covering three fourths of the planet's surface. About 97% of the earth's water is saline water, water in the oceans and 3% is fresh water contained in the lakes, ground water, rivers and frozen in glaciers. Nearly, 70% of this tiny 3% of the world's fresh water is frozen in glaciers, permanent snow cover, ice and permafrost [1]. Good drinking water quality is essential for the well being of all people. Drinking water is important for survival, so that its biological and chemical contamination is a serious problem that may have severe health effects [2]. Quality of fresh water is equally important to its quantity owing to the suitability of water for various purposes and particularly for drinking.

Bottled water consumption has been steadily growing up at the three decades in global level [3]. Water quality can have a major impact on both individuals and communities health [4]. It is very important to human health to ensure the safety of consuming drinking water [2,5].

Recently, due to the dramatically population increase on the Earth planet, consumption of bottled mineral waters has increased worldwide [6]. The water and other beverage market share of plastic bottled water in Iraqi Kurdistan Region have also increased rapidly and became incredibly popular in the last two decade. The main reason for this rapid consumption was the lack of safe and accessible tap drinking water and the taste of chemicals, particularly chlorine, used to disinfection of tap water [7]. Increasing pollution in drinking waters also amplified the demand for plastic bottled natural mineral waters. Human activities increase contamination levels through different point and nonpoint sources, which eventually cause them to be present in our drinking water resources [8]. More than 450 million people in 29 countries suffer from water shortages. Water-related concerns are also the most acute in arid or semi-arid areas. Many countries with scarce water resources rely on alternative or non-conventional water resources [9]. Nowadays, in developed countries the common and convenient practice of drinking water and other beverages from plastic bottles comes with downsides. We already know that buying a bottle of water costs more than filling a glass or reusable bottle at the tap and using plastic drinking bottles also produces negative effects on health and the environment.

This current study objected to measure and compare some physicochemical parameters of the quality of the available bottled drinking water in Iraqi Kurdistan Region and to compare with reported results on manufacturer's labeling and the WHO standards. In addition to that, the purpose of the study was also to determine the level of the following heavy metals (Cr, Co, Ni and Cu) content.

MATERIAL AND METHODS

The plastic bottled water samples analyzed in this research were obtained from local markets in the Sulaimani city. The bottled water samples represented (7) brands that were available at the time of the research. The bottled water samples were collected three times during the study and the time schedule of collection were mid November 2013, mid January 2014 and mid May 2014. For each brand sample and for each time schedule, 2 plastic bottles were purchased, one bottles for the physiochemical analysis and the second for heavy metal analysis (Table-1). Some of the bottled water samples were manufactured in Sulaimani city, while others were manufactured in other regions of the Sulaimani governorate or imported from (Turkey and Iran). All of the bottled water samples were opened in the laboratory and analyzed directly after purchasing for the following parameters as recommended by the recommended standard methods:

1.The physiochemical analyses of the following parameters including; temperature, turbidity, pH, electrical conductivity, total dissolved solid (TDS) and the soluble ions of HCO_3^- were evaluated using the standard methods reported by (APHA, 1999) [10], using these models of instruments; pH-meter (model WTW 330i/ Germany); EC-meter (model WTW 330i/ Germany); and HCO_3^- was determined by titration using EDTA.

2. (Ca^{+2} and Cl^-) ions: This ion was measured as recommended by APHA (1999) [10] using a photometer (model WTW PhotoLab Spektral/ Germany).

3. Heavy metal analysis: The heavy metals of Cr, Co, Ni and Cu were analyzed in bottled samples by using inductively coupled plasma-optical emission spectroscopy ICP-OES model Optima 2700 PerkinElmer. The standard reference solutions were from the National Institute of Standards and Technology (NIST), USA.

RESULTS AND DISCUSSIONS

In general, any bottled water in the market should be identified, and its label should expose the following information: brand name with proper type of bottled water, source of water, major ionic composition, contained volume, bottling and expiry dates in text; company name, address and country of produce. Additionally any employed treatment strategies should be mentioned on the identification label. However, the existence bottled water in particular those brands used in this study do not have the necessary information; for example, the label does not show TDS, Hardness, Ec, and so on.

Total dissolved solids (TDS) vary between the analysed brands of the bottled water (Table1). TDS comprise inorganic salts (principally Calcium, Magnesium, Potassium, Sodium, Bicarbonates, Chlorides and Sulfates) and small amounts of organic matter that are dissolved in water. TDS in drinking-water originates from natural sources, sewage, urban runoff and industrial wastewater. Salts used for road de-icing in some countries may also contribute to the TDS content of drinking-water. Concentrations of TDS in water vary considerably in different geological regions owing to differences in the solubilities of minerals, reason for not establishing a guideline value by WHO is no of health concern at levels found in drinking-water. The results for Cr for each brands of water (Table 2) are under the threshold of WHO guidelines for drinking water. The WHO Environmental Health Criteria reported that in the final section of their report (Evaluation of health risks for man), “The daily human intake through food varies considerably between regions. Typical values range from 50 to 200 µg day^{-1}. They do not represent a toxicity problem.” Later in the same section they wrote: “In the form of trivalent compounds, chromium is an essential nutrient and is relatively non-toxic for man and other mammalian species.”

Whilst, the WHO guidelines for drinking-water quality [11, 12] have recommended a provisional guideline value for chromium in drinking water of 50 µg L^{-1} “which is considered to be unlikely to give rise to significant risks to health”.

Although the guideline is based upon general considerations of the toxicity of Cr (VI), it is given in terms of total chromium. This is because of difficulties in analysing for the hexavalent form only. Copper (Cu) is both an essential nutrient and a drinking-water contaminant. The guidelines value for Cu is reported to be (2 mg/l - 2000 µg/l), which is much higher than the limit of the present study. Recent studies have delineated the threshold for the effects of copper in drinking-water on the gastrointestinal tract, but there is still some uncertainty regarding the long-term effects of copper on sensitive populations, such as carriers of the gene for Wilson disease and other metabolic disorders of copper homeostasis.

WHO (2011) [13] reported that inhaled nickel (Ni) compounds are carcinogenic to humans, and that metallic nickel is possibly carcinogenic. However, there is a lack of evidence of a carcinogenic risk from oral exposure to nickel. The guidelines value for Ni is reported to be (0.07 mg/l - 70 µg/l), where the results in (Table 2) shows all brands includes lower level of Ni, if compared with WHO guidelines.

Furthermore, As one of the objectives of current study was to compare the analysed data with both WHO standard and the reported value on the label, it can be seen from (Figure 1) the pH results for all brands include the WHO standards (6.5-8.0) (WHO, 2011) [13] , except Pinar's brand, where the labeled pH exceeded the standard; however, the later result was also included in WHO standards, when the analysed result was found for Pinar's brand

Finally, Figure 2 shows the comparison between the average results for Cl^- ion and the reported value. It can be seen all the reported labels is much less than the analysed samples; however, the still include the WHO standards (250 $mg.L^{-1}$).

Table 1: Average values of the studied physicochemical parameters in samples of brands bottled water collected during November 2013 to May 2014

Brands of bottled drinking water	pH	EC at 25°C ($\mu S\ m^{-1}$)	T°C	TDS ($mg.\ L^{-1}$)	Turbidity (NTU)	($mg.\ L^{-1}$)			
						Total Hardness	HCO_3^-	Cl^-	Ca^{+2}
OXAB	7.4	261.0	20.0	167	< 0.01	124.0	250.5	29.0	189.0
Alla	7.4	252.2	16.1	161	< 0.01	70.0	285.5	34.0	203.0
Hayat	7.9	210.7	19.5	135	< 0.01	114.7	300.1	31.0	173.0
Pinar	7.9	186.0	14.1	119	< 0.01	72.0	255.6	37.0	182.0
Kani	7.5	424.1	15.4	271	< 0.01	138.3	238.3	40.0	199.0
Life	7.6	191.6	20.6	123	< 0.01	105.3	298.1	33.0	157.0
Sirwan	7.5	340.0	16.7	218	< 0.01	88.0	242.8	37.0	146.0

Table 2: Average values of the studied heavy metals in samples of brands bottled water collected during November 2013 to May 2014

Heavy Metals	Brands of plastic bottled drinking water in ppb ($\mu g\ L^{-1}$)						
	Life	OXAB	Alla	Pinar	Kani	Hayat	Sirwan
Cr	31.78	1.49	9.04	2.20	13.73	2.41	1.64
Co	2.43	5.53	5.87	1.71	7.70	5.49	1.87
Ni	29.71	35.72	34.74	15.00	27.79	26.67	14.22
Cu	12.72	17.84	12.94	14.92	9.74	17.96	13.21

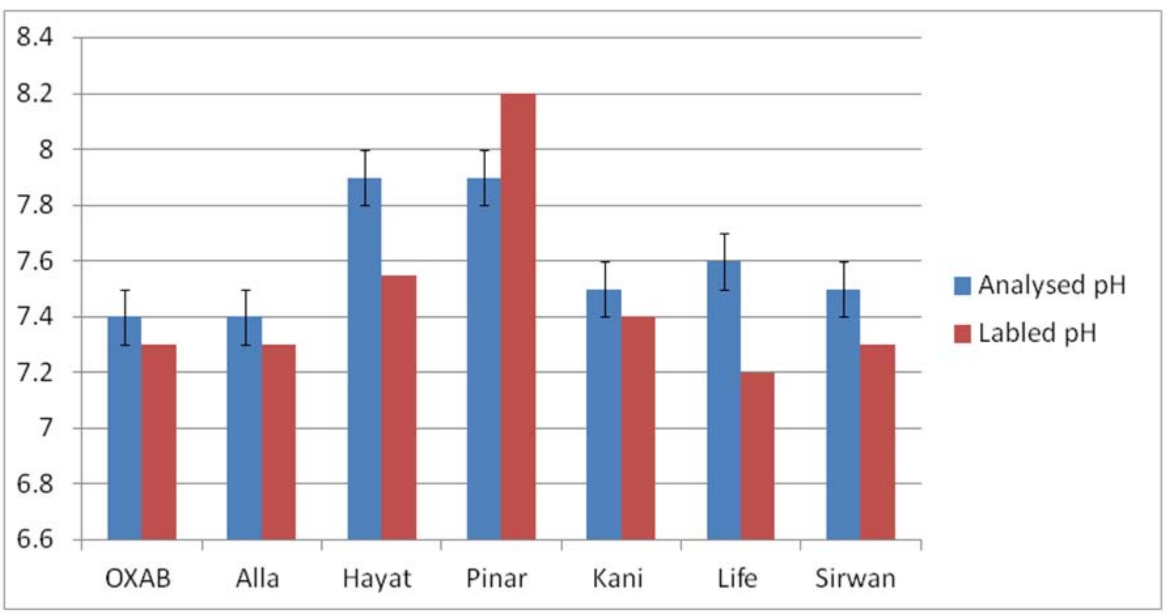

Figure-1: pH concentrations between the average pH analysed during the study, and reported pH on the label

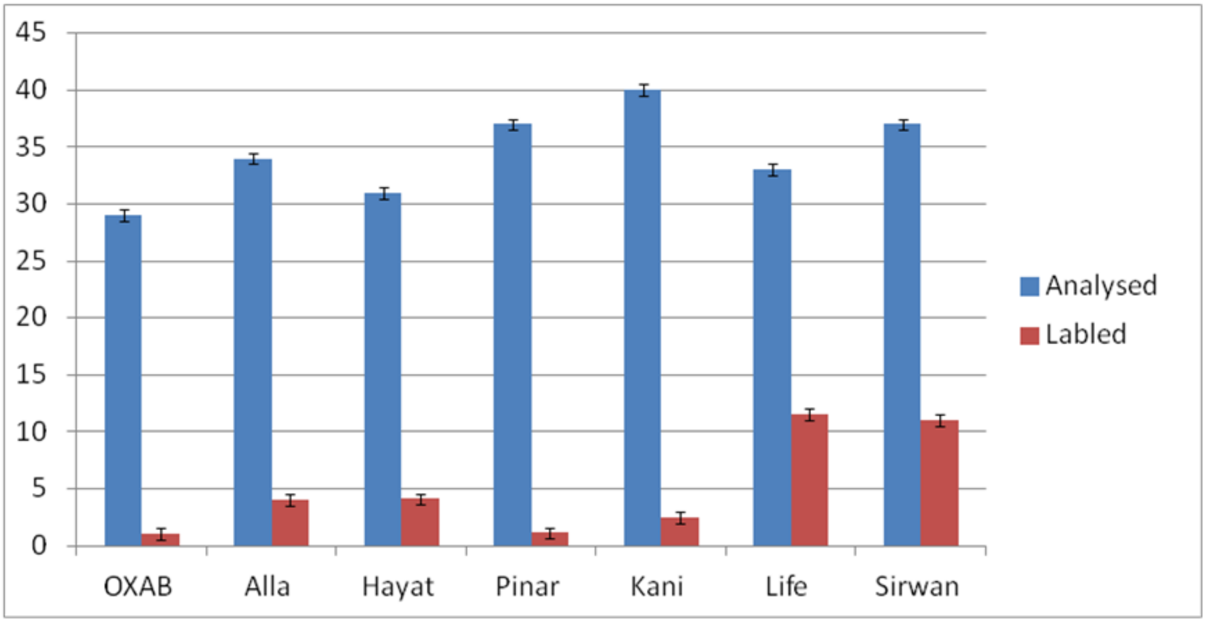

Figure-2: Average Cl^- concentrations (mgL^{-1}) in the analysed samples, and reported Cl^- concentrations on the label

CONCLUSION

Exceedence of WHO drinking water standard for Chromium & Nickel in Life, Alla, Kani, was found (Table 2) and Nickel only in OXAB and Hayat. Nickel, may have some after effects such as Respiratory, Skin, Cardiovascular Diseases Spontaneous Abortions and Birth Defects; while Hexavalent Chromium Cr (IV) is reported to be Carcinogenic, and may also damage to respiratory tract and internal organs.

Lacks of necessary information was found in the studied brands on the labels; for example, TDS, EC, and Total hardness. In addition, the analyses showed different results compared with the reported label, the qualities of the bottled waters are still suitable to drink. However, further studies are recommended; especially, analyses of microbiological tests, also analysing more heavy metals.

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