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EFFECTS OF STORAGE TEMPERATURE AND SUN LIGHT EXPOSURE ON SOME BOTTLED WATER MARKETED IN KIRKUK CITY, NORTH IRAQ

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Abstract:
The study was conducted for assessing the effect of storage temperature and sun light exposure on four bottled water (A, B, C, D company) marketed in Kirkuk city, north Iraq during February 2017 to May 2017. Physicochemical tests were including (EC, TDS, pH, turbidity, alkalinity, total hardness, Ca^{+2}, Mg^{+2}, Na^{+} and K^{+}). The pH values (7.40-7.89) show slightly alkaline trend. The electrical conductivity of bottled water sample showed with short variation (209-468 µS/cm) and all samples are with the WHO and IBWA limit for drink water. Total dissolved solid (TDS) values of sample varied between (118–288 mg/L). Turbidity values for all samples from study area fluctuated between (0.06–4.99 NTU) all samples are with the WHO limit for drink water. Total alkalinity values for all samples from study area ranged between (88–205 mg $CaCO_3$/L). Calcium and magnesium concentration in bottled water varied from 23.34–49.98 mg/L and 3.86-22.32 mg/L respectively. Sodium ion concentration ranged between 0.1-5.05 mg/L. In the present study the potassium ion concentration ranged between 0.1-1.08 mg/L. The change of physicochemical characteristic investigated when the bottled water exposed to sunlight or storage at different temperature according to WHO and IBWA.

Keywords: Bottled Water; Storage; Heavy Metals; Water Quality; Kirkuk City; North Iraq.

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1. Introduction

Water is the single most important substances in nature. It's essential for life and favorable supply must be accessible to all making strides get to secure drinking-water can result in substantial benefits to health. Every exertion ought to be made to realize a drinking-water quality as secure as practicable [1]. Water comes from three fundamental characteristic sources: rain water, underground water and surface water [2]. Secure drinking water is fundamental to people and other life forms indeed in spite of the fact that it gives no calories or natural supplements. Get to secure drinking water has made strides over the final decades in nearly each portion of the

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world, but around one billion individuals still need get to secure water and over 2.5 billion need gets to satisfactory sanitation [3].Bottled water can be characterized as water that meets all government and common directions for consumable water, is fixed in a clean holder, and is sold for human utilization. Consumable implies that the water is secure for human utilization. Be that as it may, the controls for bottled water are not the same as those for tap water [4]. Bottle producers have decreased the materials utilized through thickness decrease and intelligent auxiliary plan of water bottles. Amid dispersion and transport, bottled water is frequently set in a tall temperature environment[5].Variables such as expanding wellbeing awareness, cleanliness mindfulness, and need of well-developed open water foundation and request for useful bottled water are anticipated to fuel income and volume development of the worldwide bottled water showcase. Bottled water producers are presenting modern items with wellbeing benefits and modern flavor's which is coming about a few item dispatches within the bottled water market [6].The goal of this study is assessing the physicochemical water quality of a few bottled water that accessible in Kirkuk city, north Iraq utilizations of the come is about to measures as well as to detailed name values are displayed and the impacts of temperature and daylight on the quality of these bottled water.

2. Materials and Methods

Four brands of bottled water (A, B, C, D) were collected from various supermarkets within Kirkuk city in north of Iraq for period of February 2017 to May 2017. Each brand name and origin is given in Table 1 and 2. Electrical conductivity, Total dissolved solid, Hydrogen icon concentration, turbidity, alkalinity, total hardness, Ca^{+2}, Mg^{+2}, Na^{+} and K^{+} were analyzed utilizing standard method describe in reference [7].The study was conducted in Kirkuk city. Arranged in northern Iraq, Kirkuk is found between the Zagros Mountains within the northeast, the Lower Zab and Tigris waterways within the west, the Hamreen Mountains within the south, and the Sirwan (or Diyala) stream within the southwest.The governorate is generally small, covering 9,679 km^2, or 2.2% of Iraq [8]. Four bottled waters were collected in different shops within the city on two replication amid February-2017 to May-2017. The present study was carried out amid four month period on added up 72 natural bottled water samples of four commercial brands produced in Turkey and Iraq that accessible in Kirkuk city to expend. The water sort and source of each represented in Tables 1 and 2.

Table 1: The bottled water sort and source of each brand

Bottled water brand	**Water type**	**Source of water**
A company	Bottled Drink Water	Kirkuk – Iraq
B company	Natural Spring water	Duhok – Iraq
C company	Mineral Bottled Water	Turkey
D company	Bottled drink water	Sulaimaniya – Iraq

Table 2: Physicochemical tests in bottled water during the duration of study*

Parameters	**Units**	**Water Sample**							
		A company		**B company**		**C company**		**D company**	
		M	**L**	**M**	**L**	**M**	**L**	**M**	**L**
pH	-	7.6	6.9	7.5	7.4	7.7	7.6	7.5	7.3
EC	µS/cm	209	NI	241	NI	314	NI	433	NI

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TDS	mg/L	164	NI	118	NI	156	NI	257	NI
Turbidity	NTU	0.29	NI	0.31	NI	0.06	NI	3.98	NI
Alkalinity	mg $CaCO_3$/L	98	NI	126	NI	159	NI	187	NI
Hardness	mg $CaCO_3$/L	101	NI	141	NI	139	NI	184	NI
Ca^{+2}	mg/L	29.62	12.40	34.27	28.00	23.34	19.3 7	43.60	64.00
Mg^{+2}	mg/L	05.12	05.34	3.86	3.04	18.67	04.0 2	21.45	22.08
Na^{+}	mg/L	5.06	21.4	1.80	2.9	2.0	02.20	3.7	11.00
K^{+}	mg/L	1.08	3.80	0.37	NI	0.30	>0.2	0.50	NI

*M: measured, L: labeled, NI: not included

3. Results and Discussions

For the most part any promoted bottled water ought to be distinguished, and its name ought to uncover the taking after data: brand title with legitimate sort of bottled water, source of water, major ionic composition, contained volume, bottling and expiry dates in content; company title, address and nation of create. Furthermore any utilized treatment methodologies ought to be specified on the recognizable proof name [9]. As shown in Table 1, Most of water brands created in north of Iraq and other nation does not uncover the essential data. In this work the comes about of physicochemical properties were compared with the rule esteem of World Health Organization (WHO) [10] and International Bottled Water Association (IBWA) standards [1]. Furthermore the comes about of the physicochemical properties measured in this work compared with the detailed name values for all bottled water tests (Table.3).The study was conducted some physicochemical properties and impact of storage temperature and sun light introduction on a few bottled water marketed in Kirkuk city, north Iraq. During February -2017 to May -2017, that collected in numerous markets were shown in (Figures 1 to 10 and Tables 4 to 11) and the comes about of this properties were compared with WHO and IBWA standard has appeared in Table 3.pHis a numeric scale for acidity or alkalinity of a water arrangement. The acidity or alkalinity of a water arrangement is determined by the relative number of hydrogen particles (H+) or hydroxyl particles (OH-) show [11].

The pH values for all tests from consider region varied between (7.40-7.89) the pH esteemed appeared exceptional contrast between pH decided and the detailed on the names, the constrained of pH esteem for drink water agreeing to IBWA is indicated as 6.5-8.5 and according to WHO is indicated as (6.5–9.5) the pH of water appear marginally soluble drift. Electrical conductivity is the capacity of an arrangement to conduct an electric current. It isn't as it were connected on the concentration of separated salts and broken up gasses [12]. The electrical conductivity of bottled water sample appeared with brief variety, which extend from (209-468 µs/cm) and all tests are with the WHO and IBWA restrain for drink water. Conductivity in water is ordinarily controlled by the geography of the region through which the water stream [13]. One of the most important things to know in water quality estimation is conductivity since it gives a great thought of amount of broken up fabric within the water the distinction esteem of EC of bottled water tests may be due to the reason of the composition of water of distinctive source region. The differences of soil composition diverse mineral rock, the increase in conductivity of water went with by increment the total dissolved solid, this cruel that there near relationship between EC and TDS (WHO 2006) comparable conclusion by [14-15-16-17].

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Total dissolved solids (TDS) are the amount of mineral and salt impurities in the water, displays the concentration of dissolved minerals. TDS is the utilized to qualify the inorganic salts and little amounts of organic matter show in arrangement in water. The origin constituents are as rule calcium, magnesium, sodium, and potassium cations and carbonate (CO3), hydrogen carbonate (HCO3), chloride (Cl-), sulfate (SO4), and nitrate (NO3) anions (1). Total dissolved solid values of test shifted between (118–288 mg/L).these values were inside the WHO and IBWA benchmarks there are momentous contrasts between TDS values measured in this work with that of detailed on names, within the think about of the reasons of clear variety in TDS values where famous all through all bottled water brand may be due to the characteristic asset from which the water bottled and TDS begun, or from urban run-off and geography of the zone [2], similar conclusion by [14-15-16-17].Turbidity is the phenomenon where by a particular parcel of a light beam passing through a fluid medium is avoided from undissolved particles. In this work, the turbidity values for all tests from consider zone changed between (0.06–4.99 NTU) all tests are with the WHO restrain for drink water. Alkalinity is degree of water capacity to neutralize a solid corrosive. Add up to alkalinity is for the most part related with the nearness of carbonate, bicarbonate and hydroxide and alkalinity is degree sum of soluble materials within the water. The alkalinity values for all tests from consider region extended between (88–205 mg $CaCO_3$/L) this change in alkalinity may be related to sort and amount of rocks like sedimentary shake, particularly calcareous rock, which are wealthy in carbonate, have a high climate able silicate have a high base immersion and are well buttered and by and large donate rise to circumvented (pH=7) or slightly alkaline hard water (pH of 7.5-8.5) [18].Comparable conclusions were stated by different references [14-15-16-17]. Hardness in water is caused by the nearness of a assortment of certain dissolved polyvalent metallic particles in arrangement in water - predominantly calcium and magnesium, in spite of the fact that other particles for illustration, aluminum, barium, press, manganese, strontium, and zinc, too contribute. The source of the metallic particles are regularly sedimentary rocks, and the foremost common are limestone (CaCO3) and dolomite Ca, Mg(CO3)2, the determination of water hardness could be a valuable test that gives a degree of quality of water for family units and mechanical employments [19]result of total hardness in percent consider changes from 101 mg $CaCO_3$/L recorded in A water and maximum of 192 mg $CaCO_3$/L recorded in D water, this cruel the hardness in bottled water changed from decently to tolerably difficult water, this may be due to source, topographical and soil properties of the catchments zone, different human exercises as well as climate condition have been to impact on hardness esteem in any water source [1]. Calcium and magnesium are the most common particles found within the hard water which can take an interest for made it [20]. Calcium and magnesium respected vital major cations in water. Calcium and magnesium concentration in bottled water shifted from 23.34–49.98 mg /L and 3.86-22.32 mg/L separately, this variety of concentration of both cations may be related chemical weathering of shake and mineral containing of each particle such as sedimentary shake, limestone, dolomite, gypsum, aragonite, mineral of molten shake feldspar, amphibole, and pyroxene and pH of each source [21] generally calcium ion concentration dominated over magnesium ion concentration of this study, this case related to chemical properties of the soil and geographical data of water source with comparable conclusion by expressing a few analysts [14-15-16-17]. Sodium is the vital cation in hydrosphere, and is the key component in bottled water and fundamental for wellbeing, tall level of sodium cause issue and moo level cause slim down is frequently exhorted, sodium particle concentration extended between 0.1 -5.05 mg/L. Potassium in spite of the fact that it is an basic component, the body to discover troublesome to

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bargain with abundance potassium coming about in kidney stretch [22]. Within the present study the potassium particle concentration extended between 0.1-1.08 mg/L. Sodium concentration in bottled water more abundance than potassium, usually due to that b potassium enters in to the structure of certain clay mineral amid the weathering forms and the higher resistance to weathering forms and higher resistance to weathering of numerous potassium mineral in connection of sodium minerals that less resistance to weathering subsequently sodium esteem more than potassium esteem. The contrast between sodium concentration and potassium esteem totally different bottled water in this study may be considered to geography and soil arrangement of the waste bowl, climatic testimony, human action, conjointly impact the ionic composition by the chemical composition of ground water and atmospheric statement of solute through damp and dry precipitation [17]. These conclusion was shown similarity with different references implied [14-15-16-17].

Table 3: Some universal standard related with bottled water quality

Some tests	**Unite**	**WHO (2006) drinking water**	**IBWA Bottled water**
pH	-	6.5 - 9.5	6.5-8.5
EC	µS/cm	1000	1000
TDS	mg L^{-1}	500	500
Turbidity	NTU	5	0.5
Alkalinity	mg $CaCO_3$/L	200	200
Hardness	mg $CaCO_3$/L	200	200
Ca^{+2}	mg L^{-1}	100	100
Mg^{+2}	mg L^{-1}	30	30
Na^{+}	mg L^{-1}	20	20
K^{+}	mg L^{-1}	10	10

Table 4: Impact of temperature on "A" bottled water after 10 days in Kirkuk

Exposed to temperature	**pH**	**EC**	**TDS**	**Turbidity**	**Alkalinity**	**Hardness**	**Ca^{+2}**	**Mg^{+2}**	**Na^{+}**	**K^{+}**
0°C	7.60	209	164	0.29	103	101	29.62	05.12	5.06	1.08
25°C	7.54	210	165	0.33	96	107	30.31	06.32	0.5	1.02
35°C	7.52	221	171	0.89	93	112	37.16	07.89	0.1	1.01
45°C	7.51	229	180	0.95	88	125	38.92	09.88	0.1	1.05

Table 5: Impact of temperature on "B" bottled water after 10 days in Kirkuk

Exposed to temperature	**pH**	**EC**	**TDS**	**Turbidity**	**Alkalinity**	**Hardness**	**Ca^{+2}**	**Mg^{+2}**	**Na^{+}**	**K^{+}**
0°C	7.50	241	118	0.31	126	141	34.27	3.86	1.80	0.37
25°C	7.54	243	121	0.37	123	144	34.80	3.92	0.2	0.10
35°C	7.62	248	123	0.90	120	148	35.54	4.23	0.3	0.10
45°C	7.60	251	128	0.98	115	152	36.12	4.78	0.4	0.10

Table 6: Impact of temperature on "C" bottled water after 10 days Kirkuk

Exposed to temperature	**pH**	**EC**	**TDS**	**Turbidity**	**Alkalinity**	**Hardness**	**Ca^{+2}**	**Mg^{+2}**	**Na^{+}**	**K^{+}**
0°C	7.70	314	156	0.06	159	139	23.34	18.67	2.0	0.30
25°C	7.78	318	158	0.08	156	142	23.84	18.77	0.8	0.10

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35°C	7.89	322	162	0.23	153	143	24.23	18.80	0.9	0.20
45°C	7.86	329	168	0.45	147	146	24.76	18.80	0.9	0.20

Table 7: Impact of temperature on "D" bottled water after 10 days Kirkuk

Exposed to temperature	pH	EC	TDS	Turbidity	Alkalinity	Hardness	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}
0°C	7.5	433	257	3.98	187	184	43.60	21.45	3.7	0.50
25°C	7.5	438	259	4.12	186	187	43.87	21.48	3.3	0.40
35°C	7.6	442	263	4.52	181	189	44.68	21.88	3.2	0.20
45°C	7.6	452	268	4.68	176	190	45.23	21.98	3.3	0.10

Table 8. Impact of temperature on "A" bottled water after 20 days Kirkuk

Exposed to temperature	pH	EC	TDS	Turbidity	Alkalinity	Hardness	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}
0°C	7.40	209	164	0.29	98	101	29.62	05.12	5.06	1.08
25°C	7.43	216	173	0.38	107	112	32.65	06.87	0.6	1.02
35°C	7.48	225	180	0.97	109	108	34.60	08.78	0.6	1.02
45°C	7.46	230	188	1.12	104	118	35.32	09.34	0.6	1.02

Table 9. Impact of temperature on "B" bottled water after 20 days Kirkuk

Exposed to temperature	pH	EC	TDS	Turbidity	Alkalinity	Hardness	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}
0°C	7.62	241	118	0.31	126	141	34.27	3.86	1.80	0.37
25°C	7.51	248	127	0.44	128	150	35.65	4.12	0.4	0.20
35°C	7.65	252	130	0.98	129	155	36.28	4.25	0.4	0.20
45°C	7.60	255	135	1.34	129	153	36.89	4.98	0.5	0.20

Table 10: Impact of temperature on "C" bottled water after 20 days Kirkuk

Exposed to temperature	pH	EC	TDS	Turbidity	Alkalinity	Hardness	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}
0°C	7.70	314	156	0.06	159	139	23.34	18.67	2.0	0.30
25°C	7.78	318	168	0.09	167	148	25.45	18.90	1.2	0.2
35°C	7.85	325	173	0.92	177	154	28.32	19.24	1.4	0.10
45°C	7.80	329	181	0.99	176	159	29.43	19.46	1.6	0.20

Table 11: Impact of temperature on "D" bottled water after 20 days Kirkuk

Exposed to temperature	pH	EC	TDS	Turbidity	Alkalinity	Hardness	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}
0°C	7.50	433	257	3.98	187	184	43.60	21.45	3.7	0.50
25°C	7.55	446	268	4.32	190	187	48.55	21.80	3.3	0.30
35°C	7.68	453	279	4.89	205	189	49.67	21.99	3.3	0.40
45°C	7.63	468	288	4.99	201	192	49.98	22.32	3.3	0.10

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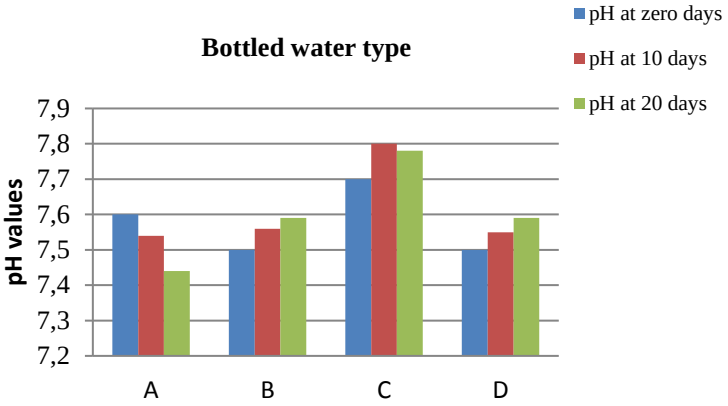

Figure 1: pH recorded in diffirent bottled water that expsures to sun light.

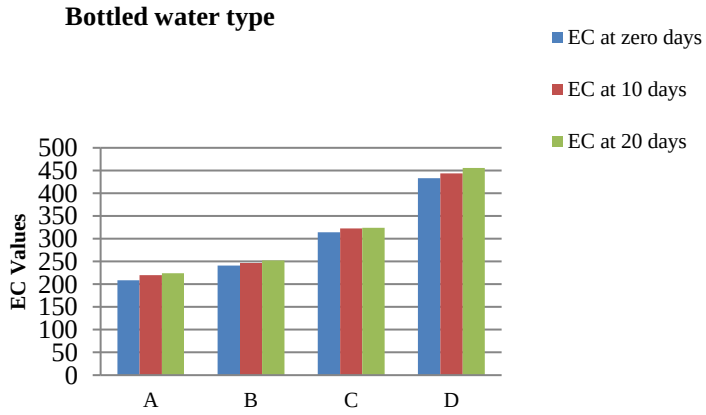

Figure 2: Electerical conductivity recorded in different bottled water water that exposures to the sun light.

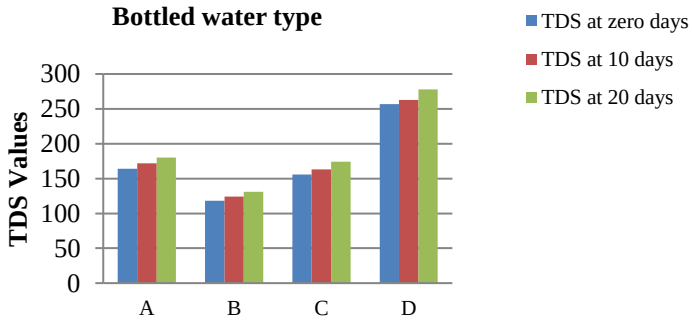

Figure 3. Total dissolved solids recorded in different bottled water that exposures to the sun light.

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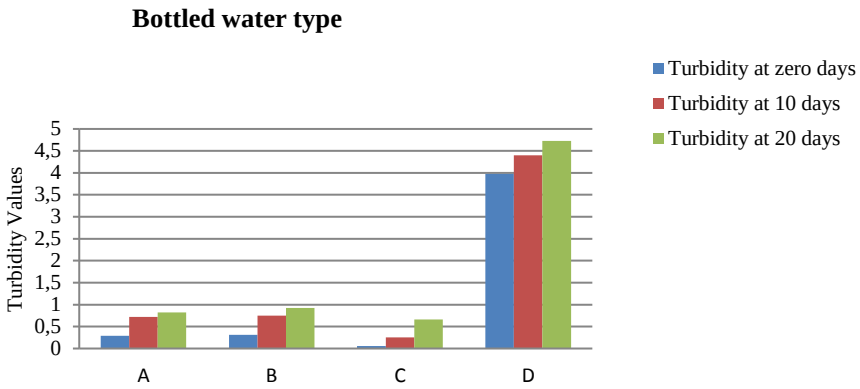

Figure 4: Turbidity recorded in different bottled water that exposures to the sun light.

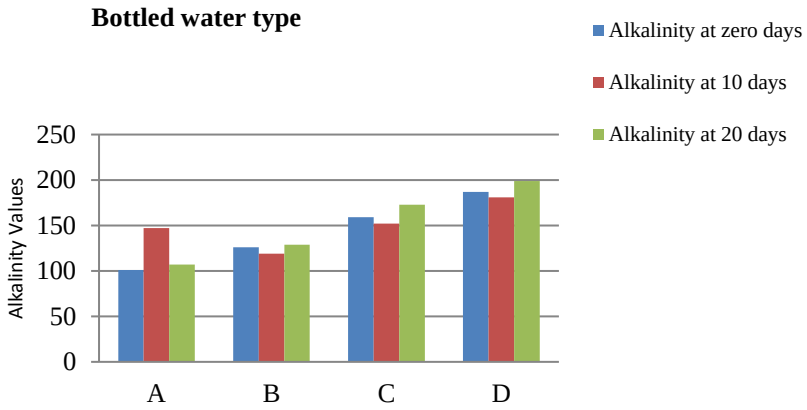

Figure 5: Alkalinity recorded in different bottled water that exposures to the sun light.

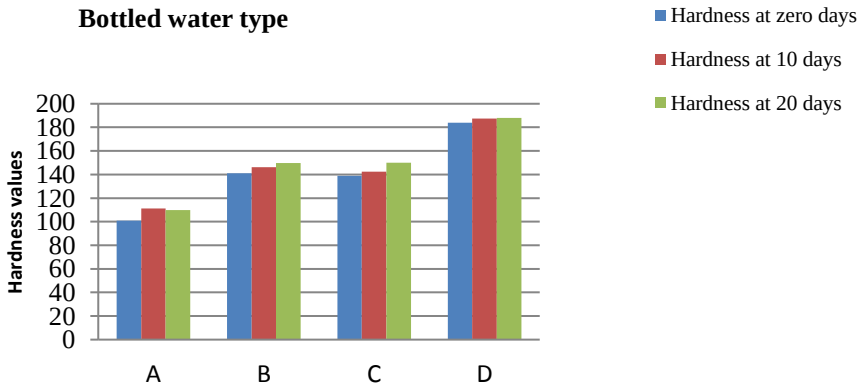

Figure 6: Hardness values recorded in diffrent bottled water that exposures on sun light.

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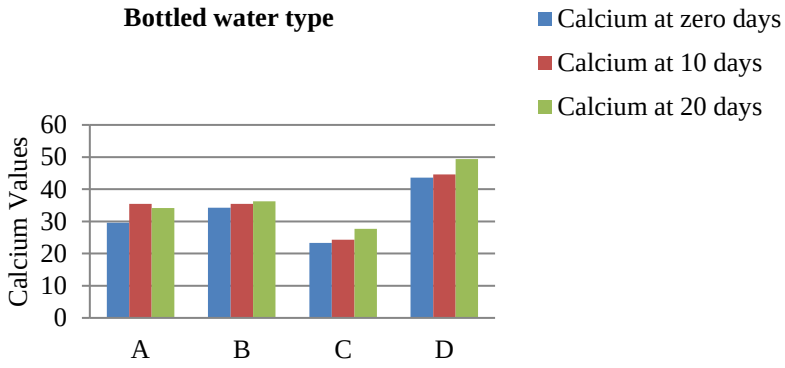

Figure 7: Calcium recorded in different bottled water that exposures to the sun light.

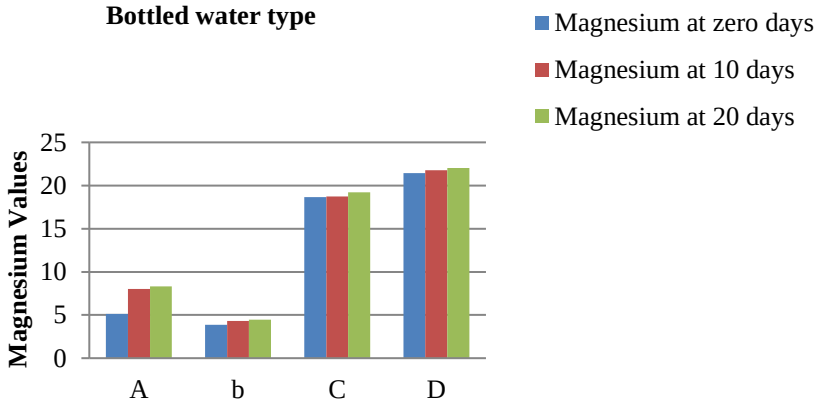

Figure 8: Magnesium recorded in different bottled water that exposures to the sun light.

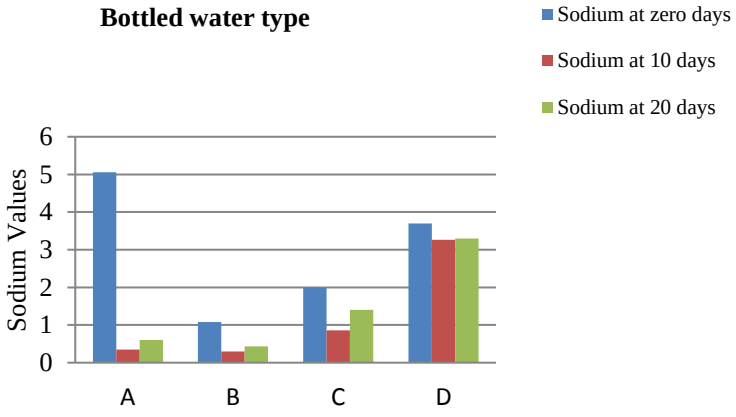

Figure 9: Sodium recoded in different bottled water that exposures to the sun light.

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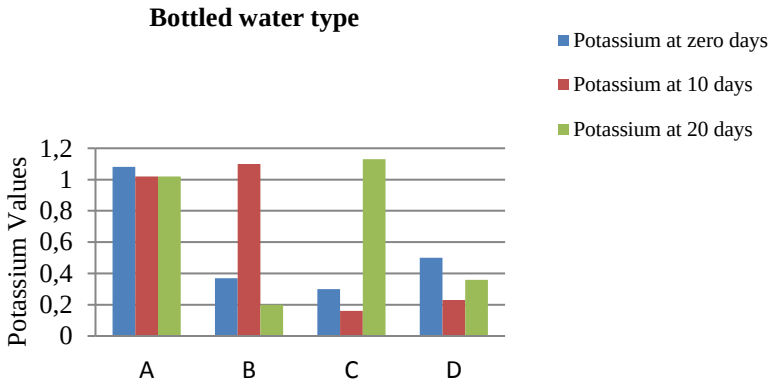

Figure 10: Potassium recorded in bottled water that exposures to the sun light.

4. Conclusions and Recommendations

1) The information reported on the four bottled water (A, B, C, D) labels does not represent the genuine values of physicochemical properties.
2) Found some Varity between bottled water brands.
3) Generally, the storage of bottled water exposure to sunlight leads to expanding the values of a part of factors (Na, Mg, Ca, hardness, alkalinity, turbidity, TDS, EC and pH) and diminishing one variable (K).
4) Storage materials and waiting times of drinking water should maintain according to the water standards as WHO, IBWA etc.
5) Maintenance of distribution system and methods must be planned, implemented and operation- protection of the treatments must be undertaken by the authority control.

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