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ORIGINAL RESEARCH PAPER

A comparative study for quality of local and imported commercially available bottled water brands

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ABSTRACT

In this study, the quality of Omani and United Arab Emirates bottled water brands which are sold in Oman were assessed by comparing the chemical composition indicated on manufacturer's label with local and international bottled water standards. Results indicated that all the bottled water brands are complying with local and international standards. According to piper diagram, the most dominant water type among Omani brands is mixed Ca^{2+}-Mg^{2+}-Cl^{-} and among United Arab Emirate brands is calcium chloride. Hierarchical cluster analysis divided Omani and United Arab Emirate brands into four groups based on similarity in chemical composition. Some of the Omani and United Arab Emirate brands have the same chemical composition but marketed under different names. Calcium concentration in Omani and United Arab Emirate brands is low compared to imported mineral water brands, and their contribution towards recommended dietary allowances of calcium for adults is only 3%. Both Omani and United Arab Emirate brands used in this study are meeting the United States Food and Drug Administration's very low sodium category requirements and are suitable for individuals on a severely restricted sodium diet.

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INTRODUCTION

The Sultanate of Oman is situated on Arabian Peninsula's south-east coast. On an average the plains of Oman receive less than 100 mm of rainfall per year, whereas the mountain areas receives up to 350 mm per year. It was estimated that, Oman is receiving 19,250Mm^3 of water in the form of rainfall annually, of this 80% is evaporating back to the atmosphere due to high temperatures, and the remaining is contributing towards run-off and groundwater recharge. In the rural areas of Oman, the main source of drinking water is flaj system (ancient water channels) and groundwater, while in urban areas tap water is supplied through water supply network by the public authority for Electricity and water, Oman (PAEW). Desalinated sea-water is the main source for tap water supply in Oman due to unavailability of sufficient natural water resources. Due to the strong economic and demographic growth in Oman over recent decades, Oman has witnessed a rapid and persistent growth in water demand (Atkinson, 2018). Though good quality tap water is

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supplied at cheaper rate in many countries demand for bottled water has grown tremendously over the past forty years at a worldwide annual growth rate of 7 % (Ferrier *et al.,* 2001). Health concerns related to drinking water is the main driving factor for bottled water industry. Due to salty taste and bacterial contamination of tap water, bottled water is preferred over tap water for drinking in Oman (Al Aamri et al., 2017). According to local bottled water suppliers, the market demand for bottled water in Oman was 23 million cases (each case is 8 ounces) per year in 2012 with a per capita consumption of 693 cases per year, and since 2007 the market has grown by about 6% per year. In 2013, 183 bottled drinking water factories were present in Gulf Cooperation Council (GCC) countries. Nearly 52.5 % were in Saudi Arabia, 22.4% in UAE, 9.8% in Oman, 6.6% in Bahrain, 5.5% in Qatar and the remaining in Kuwait (sreedhar reddy *etal.,* 2018). The Oman bottled water market has 25 active players, 11 of which are based in the UAE. Nutrient minerals like Calcium, Magnesium, Sodium, potassium, Iron, Zinc, Copper, Chromium, Iodine, Cobalt, and Selenium are required for the proper functioning of the human body physiologically and physicochemically (van der Aa, 2003). Ideal bottled water should have high concentrations of magnesium and calcium and low levels of sodium (Garzon *et al*., 1998). Epidemiological and clinical studies have proved that magnesium can lower sudden death rates, calcium prevents osteoporosis and sodium contributes to hypertension in humans (Garzon *et al.,* 1998). In the Sultanate of Oman, no work was done to investigate and quantify the mineral content of bottled drinking water and evaluate its contribution to DRI. The objective of this article is to investigate the quality, compliance with national and international standards, classification and contribution of dietary nutrients of local and imported bottled water brands sold in Oman. The current study has been conducted in Nizwa, Oman in 2018-19.

MATERIALS AND METHODS

For this investigation 20 local (Omani) bottled drinking water brands, 20 imported bottled drinking water brands (produced in UAE) and three mineral water brands (produced in France) were purchased from the hypermarkets located in Nizwa and Muscat. Omani and UAE brands were numbered 1 through 20 in order to keep the brand names confidential and this numbering was used throughout the text and in the analyses. Using Rockware AQqua version 1.5 software, the chemical data of the bottled water brands were graphically treated by plotting in a piper diagram and Durov plot to better understand hydrochemistry, water quality and water types. IBM SPSS statistics 21 was used to perform Hierarchical cluster analysis (HCA). HCA forms statistically distinct groups (clusters) based on similarity in the chemical quality. Cluster analysis was performed on the water quality data containing 8 variables by means of the Ward's method using squared Euclidean distance as a measure of similarity. The HCA results were presented using dendrogram. DRIs are globally adopted nutrient-based reference values which includes Estimated Average Requirement (EAR), the recommended dietary allowances (RDA), the adequate intake (AI), and the tolerable upper intake level (UL) (Dietary Reference Intakes, 2009). Assuming a daily intake of two liters of bottled water per day, the dietary nutrient contribution of bottled water was calculated by multiplying the nutrient concentration (mg/L) with daily intake and compared to RDA/UL.

RESULTS AND DISCUSSION

Chemical characteristics and compliance with quality standards of bottled waters

Chemical characteristics of Oman and UAE bottled water brands are presented using series plot in Figs. 1 and 2. Bottled water brands sold in Oman, must disclose concentration of TDS, potassium, chloride, Sulphate, , carbonate, bicarbonate ,calcium, sodium, magnesium, total hardness, nitrate, fluoride, TDS in Parts per million (ppm) , pH and the net volume in metric system on their labels. Label must also include production and expiry date and information about added fluorine (GSO, 2008). Eighteen out of twenty UAE brands are abiding to the labeling requirement; whereas only twelve out of twenty Omani brands are abide to labeling requirement. Labels of some of the Omani brands did not disclose concentration of bicarbonates, nitrates, total hardness and sulphates. None of the brands (both Oman and UAE), are labeled as Fluoridated water.

Tables 1 and 2 present the maximum, minimum, standard deviation and mean values chemical parameters of Omani and UAE brands and comparison with GCC, WHO and SASO standards for drinking water. The difference between the lowest

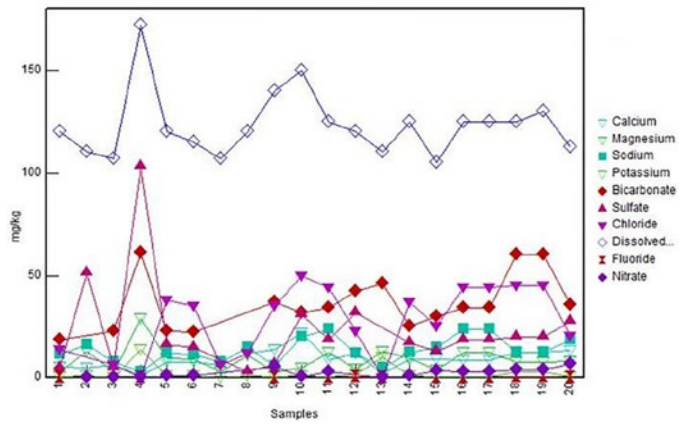

Fig. 1: Series plot for Omani brands

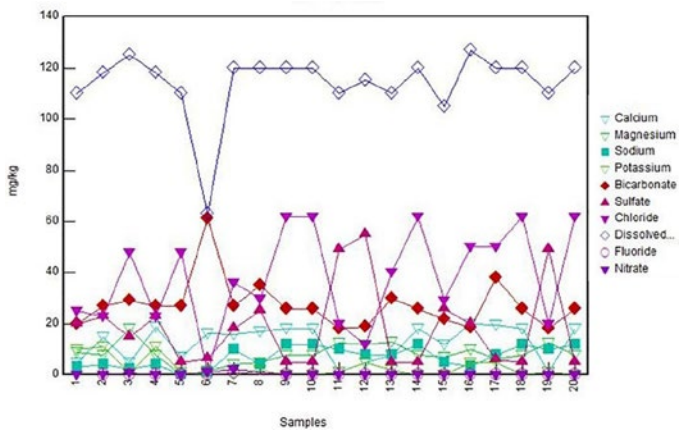

Fig. 2: Series plot for UAE brands

and highest concentrations was one to twenty orders of magnitude for most of the elements. The different geological origins of the water can be attributed to these great variations. From Tables 1 and 2, it is clear that all the parameters complying with the standards.

The pH value of Omani bottled water samples are in the range of 7 to 7.8 and UAE bottled water samples range from 6.8 to 7.7. According to GSO, WHO and SASO standards recommended pH range for drinking water is 6.5 to 8.5. The maximum TDS value of 172 mg/L was observed in Omani brands and 131 mg/L in UAE brands. Significant variation is observed between Omani and UAE brands in TDS concentration. This is variation is due to difference in solubility of minerals in different geological regions. Usually water considered unfit for human consumption when its TDS level exceeds 1200 mg/L. Most often, the presence of potassium, chlorides and sodium causes high levels of TDS. These ions have little or no short-term effects, but toxic ions (nitrate ,boron, fluoride and others) may also be dissolved in the water (WHO, 2011). The highest concentration of HCO_3 found in Omani and UAE brands was 61 and 38 mg/L respectively, and the lowest recorded in Omani and UAE brands was 18.4 mg/L and 13 mg/L respectively. Natural mineral or spring water contains a lot of bicarbonates, ranging from a few tens to hundreds of mg/L for still waters and several hundred to thousands of mg/L for sparkling waters (Hazzab, 2011). It has been reported that, drinking of mineral water rich in bicarbonates (BMW) prevent or improve type 2 diabetes (T2D) in humans (Shinnosuke Murakami *et al.*, 2015). Chloride is one of the most commonly found anion in water and its concentration

Table 1: Comparison of Omani bottled water quality with standards

Parameter	Number of brands	Mean ± SD	Minimum-Maximum	Max. permissible limit		
				GSO-1025 (2008)	WHO (2008)	SASO (2009)
Calcium (mg/L)	20	9.38±4.68	1-22		100	200
Magnesium (mg/L)	20	9.75±5.97	3-29	150	50	150
Sodium (mg/L)	20	13.4±6.1	3-23.6		200	100
Potassium (mg/L)	20	2.63±3.49	0.26-14		12	
Chloride (mg/L)	19	27.3±16.9	0.02-50		250	150
Sulfate (mg/L)	18	26.3±23	3-103.2	250	250	150
Bicarbonate (mg/L)	17	36.7±13.51	18.4-61		125-250	
Fluoride (mg/L)	12	0.28±0.19	0.03-0.6	0.8-1.5	1.5	0.8-1.5
Nitrate (mg/L)	17	2.49±2.1	0.1-7		50	50
Total Hardness (mg/L)	13	65±26	38-119	200		
pH	20	7.38±0.29	7-7.8	6.5-8	6.5-8.5	6.5-8.5
TDS (mg/L)	20	124±16	105-172	100-600	1000	100-500

Table 2: Comparison of UAE bottled water quality with standards

Parameter	Number of Brands	Mean ± SD	Minimum-Maximum	Max. permissible limit		
				GSO-1025 (2008)	WHO (2011)	SASO (2009)
Calcium (mg/L)	20	13±6.49	1.2-20		100	200
Magnesium (mg/L)	20	8.41±4.15	0.3-18	150	50	150
Sodium (mg/L)	19	7.5±3.82	1-12		200	100
Potassium (mg/L)	20	2.75±3.45	0.077-11		12	
Chloride (mg/L)	20	38.2±19.17	1-12		250	150
Sulfate (mg/L)	20	19.5±16.55	4.9-55	250	250	150
Bicarbonate (mg/L)	20	28.85±9.64	18-61		125-250	
Fluoride (mg/L)	18	0.14±0.239	0-1	0.8-1.5	1.5	0.8-1.5
Nitrate (mg/L)	19	0.423±0.55	0.06-2.2		50	50
Total Hardness (mg/L)	19	61.875±16	10-91	200		
pH	20	7.38±0.25	6.8-7.7	6.5-8	6.5-8.5	6.5-8.5
TDS (mg/L)	20	112±13.65	63-127	100-600	1000	100-500

ranged from less than 1 to 50 mg/L in the brands of Oman and ranged from 12 to 62 mg/L in UAE brands. None of the studied samples have chloride levels that exceed the recommendations of GSO, WHO and SASO standards. Chloride levels exceeding 250 mg/L may impart detectable taste in water, but other cations involved affects the threshold of chloride. The taste thresholds for sodium chloride and calcium chloride in water range from 200 to 300 mg/L (Zoeteman *et a.,* 2014). The sulfate concentration in all the samples studied falls within GCC and other international standards for drinking water. Generally presence sulfate in drinking water is harmless, but imparts taste. The taste threshold for sodium sulfate is 250–500 mg/L, for calcium sulphate is 250–1000 mg/L, and for magnesium sulphate is 400–600 mg/L in drinking water. Catharsis, dehydration and gastrointestinal irritation are the major physiological effects results from consuming of large amounts of sulfate (Cocchetto *et al.,* 1981; Morris *et al.,* 1983). Concentration of nitrate(NO_3) in the studied water samples varied from 0.1 to 7 mg/L with a mean value of 2.49 mg/L in Omani brands and varied from 0.06 to 2.2 mg/L with a mean value of 0.331 mg/L in UAE and meeting WHO, SASO and GCC drinking water standards. Methemoglobinemia, called ' blue baby syndrome, ' is the primary health concern with high concentrations of NO_3 in drinking water. NO_3 can change to NO_2 in infants ' stomachs, which can then oxidize hemoglobin to methemoglobin, making oxygen transport around the body difficult (WHO, 2011). Fluoride (F) is a vital component for healthy teeth and is therefore added to the drinking water to prevent caries in some countries. Fluoride concentrations in the studied water samples varied from 0.03 and 0.6 mg/L with an average value of 0.23 in Omani brands and vary between 0 and 1 mg/L with an average value of 0.11 mg/L in UAE

brands. The maximum permissible limit for fluoride in drinking water is 1.5 mg /L (WHO, 2011). None of the Omani and UAE water brands met the minimum fluoride requirement of 0.8 mg/L in accordance with GSO 1025/2008 and other international standards. Sodium (Na) concentrations ranged from 3 to 23.6 mg/L with an average value of 13.45 mg/L (Tables 3 and 4). Calcium (Ca) concentrations ranged from 1 to 22 mg/L, with an average value of 9.3 mg/L. All the water brands studied have Ca levels falling within the SASO and WHO limits. Water from natural sources usually contain up to 10 mg/L of calcium and goes up to 800 mg/L were found in some natural water. Depending on the associated anion, the taste threshold for the calcium ranges from 100 to 300 mg/L (Arvin et al., 2017). Magnesium concentrations range from 3 to 29 mg/L with an average value of 9.7 mg/L and all the studied water brands are meeting GCC and SASO standards for magnesium. Potassium concentration ranged from 0.26 to 14 mg/L in the

Table 3: Classification of Omani and UAE bottled brands based on piper diagram

No.	Water Types	Brands	
		Oman	UAE
1	Mixed Ca^{2+}-Mg^{2+}-Cl^{-} type	5,6,11,12,14,16,17,9,10,18,19, 1,15,20	
2	Calcium chloride type	4	1,2,3,4,5,7,8,9,10, 11,12,13,14,15,16,17,18,19,20
3	Sodium chloride type		
4	Sodium bicarbonate type		
5	Calcium bicarbonate type	3	
6	Mixed Ca^{2+}-Na^{+}-HCO^{3-} type		
7	Ca^{2+}-Mg^{2+}-Cl^{-}-SO_4^{2-} type		
8	Ca^{2+}-Mg^{2+}- HCO^{3-} type		6
9	Na^{+}-K^{+}-Cl^{-}- SO_4^{2-} type		
10	Na^{+}-K^{+}- HCO^{3-} type		

Table 4: Classification of Omani and UAE bottled water brands based on Durov diagram

NO.	Water Types	Brands	
		Oman	UAE
1	HCO_3 and Ca dominant, frequently indicates recharging waters in limestone, sandstone, and many other aquifers		5
2	This water type is dominated by Ca and HCO_3 ions. Association with dolomite is presumed if Mg is significant. However, those samples in which Na is significant, an important ion exchange is presumed	9	8
3	HCO_3 and Na are dominant, normally indicates ion exchanged water, although the generation of CO_2 at depth can produce HCO_3 where Na is dominant under certain circumstances		
4	SO_4 dominates, or anion discriminant and Ca dominant, Ca and SO_4 dominant, frequently indicates recharge water in lava and gypsiferous deposits, otherwise mixed water or water exhibiting simple dissolution may be indicated		3,9,10,13,16
5	No dominant anion or cation indicates water exhibiting simple dissolution or mixing	1,3,4,5,6, 10,11,12,14,15, 16,17,18,19,20	1,2,4,6,7, 11,12,14,15, 17,18,19,20
6	SO_4 dominant or anion discriminate and Na dominant; is a water type that is not frequently encountered and indicates probable mixing or uncommon dissolution influences		
7	Cl_2 and Na dominant is frequently encountered unless cement pollution is present. Otherwise the water may result from reverse ion exchange of Na-Cl waters		
8	Cl_2 dominant anion and Na dominant cation, indicate that the ground waters be related to reverse ion exchange of Na-Cl waters		
9	Cl_2 and Na dominant frequently indicate end-point down gradient waters through dissolution.		

brands studied. Except one Omani brand, remaining all the brands are meeting WHO (2011) standard for Potassium in drinking water.

Hydro geochemical facies

Major ions present in Omani and UAE bottled water brands were plotted on Piper diagram (Fig. 3a and Fig. 3b) and Durov plot (Figs. 4a and 4b) to classify and designate ionic nature of bottled water. Both diagrams show similarities and differences between water samples, and those of similar characteristics tend to form a group. (Todd, 2004).

Classification of bottled water brands based on Piper diagram and Durov plot presented in Tables 3 and 4. Since some of the Omani brands did not provide information about concentration of bicarbonates, chlorides, sulphates, hence they were not included in this classification.

From the piper diagrams (Figs. 3a and 3b), it is clear that most of UAE brands (65 percent) are calcium chloride type and the rest are mixed type. 25 percent of Omani brands are calcium chloride type, 25 percent are sodium chloride type and sodium carbonate type, and the remaining is mixed type. Durov plots (Figs. 4a and 4b) reveal that there are mainly two geochemical processes that could have affected the source of water for both Omani and UAE brands. 1) In most of the Omani and UAE brands, there is "no dominant anion or cation indicating simple dissolution or mixing" 2) In few UAE brands

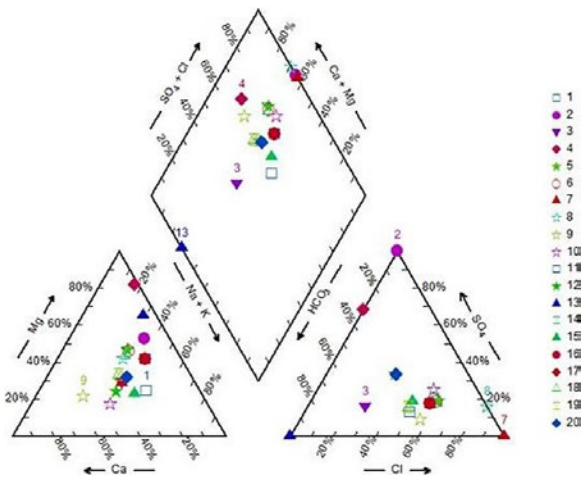

Fig.3a: Piper diagram for Omani brands

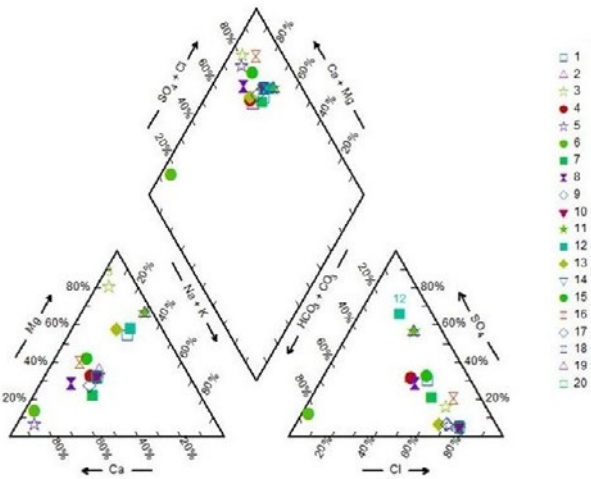

Fig. 3b: Piper diagram for UAE brands

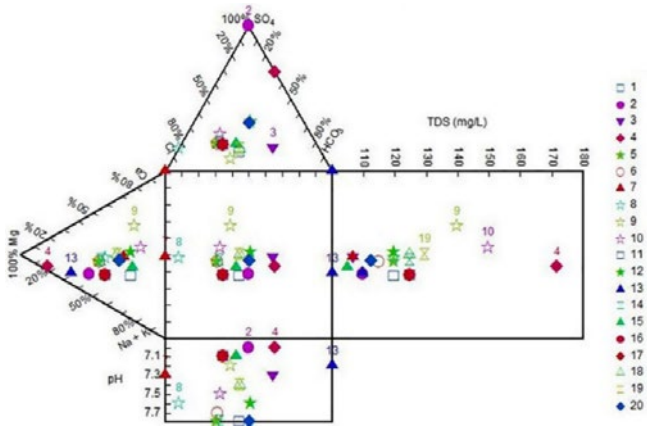

Fig.4a: Durov diagram for Omani brands

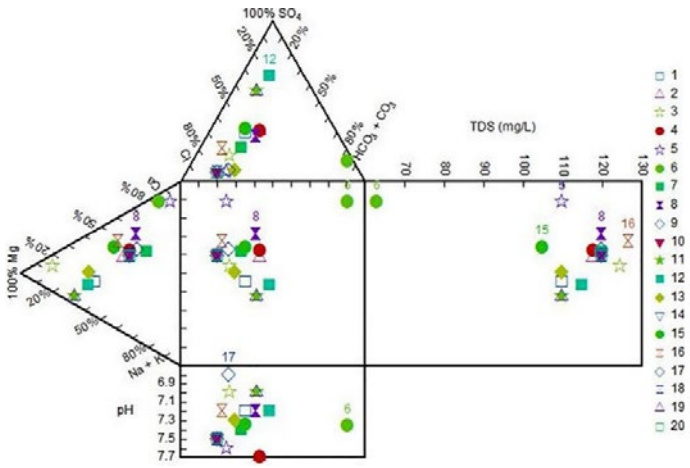

Fig. 4b: Durov diagram for UAE brands

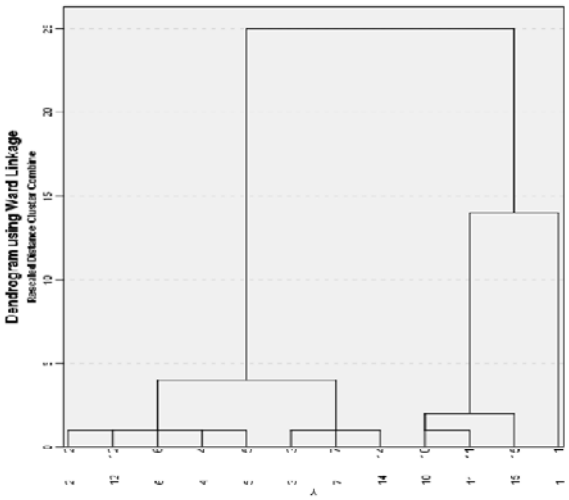

Fig. 5: Dendrogram for Omani bottled drinking water brands

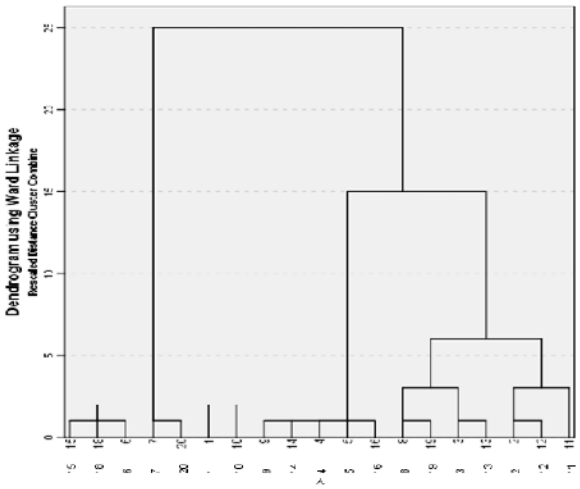

Fig. 6: Dendrogram for UAE bottled drinking water brands

"Ca and SO_4 is dominating, indicating recharge of water in lava and gypsiferous deposits, otherwise mixed water or water exhibiting simple dissolution".

Hierarchical cluster analysis (HCA)

HAC was used to search for natural grouping among Omani brands and UAE brands. The results of the HCA are presented using dendrogram (Figs. 5 and 6). The resulting dendrogram have classified both Omani brands and UAE brands in to four major groups. The squared Euclidean distance between some the Omani (Example: 2 and12; 4 and 5) and UAE brands (Example: 4 and 5; 4 and 14; 4 and 16; 9& and 5; 14 and 5) is zero. This indicates that these brands are from the same source of water, but marketed under different brand names. Among Omani brands, brand No: 1 is grouped separately due to low calcium, chloride and sodium concentration and high magnesium and total dissolved solids concentration compared to other Omani brands.

Dietary nutrient contribution

Inadequate daily intake of calcium and magnesium is becoming common throughout the world. According to 2011 National Dietary Intake Survey (ENIDE) data 82 percent of women aged between

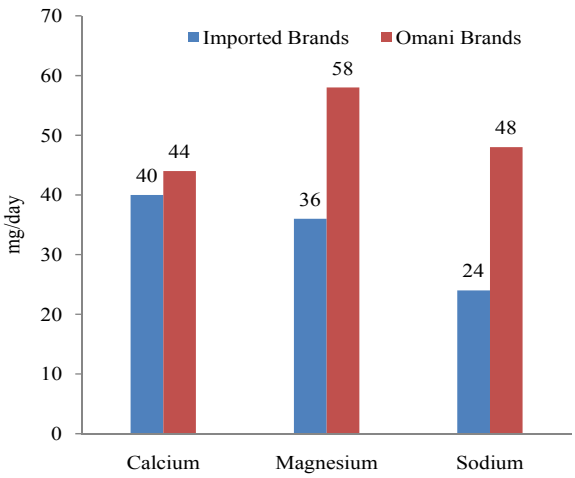

Fig. 7: Dietary nutrient contribution

45 and 64 years have inadequate calcium intake and 30 percent of the population have inadequate magnesium intake in Spain (Cíntia Ferreira-Pêgo *et al.,* 2016). Approximately 54 million people are estimated to have osteoporosis and low bone mass in the United States of America (Wright et al., 2014). Many of these cases could be due to drinking water that is pure and does not have enough minerals to maintain mineral ion balance in the bones. Mineral salt additives are generally added to bottled waters purified by distillation or reverse osmosis (RO) to recover for lost minerals (calcium, potassium and magnesium) during evaporation or by high rejection of RO Membrane. Although the minerals in water are not a substitute for the minerals that humans get from their diet, they can be an important supplement. The relative contribution of water to the total dietary intake of selected trace elements and electrolytes is between 1 and 20 percent. Calcium and magnesium are the micronutrients with the largest proportion of intake from drinking water relative to that provided by food. Water can provide up to 20 percent of the total daily intake required for these elements. For most other elements, drinking water provides less than 5% of total intake (Abtahi *et al.,* 2016). In some of the geographic regions drinking water contributes high dietary intake of fluoride and arsenic (Murshid, 2003; Tahir et al., 2012). Table 5 shows the daily intakes of calcium, magnesium, and sodium recommended by the Institute of Medicine, adapted to the world population.

Fig. 7 represents the maximum dietary nutrient contribution of UAE and Omani bottled water brands and Table 6 presents a comparison with imported mineral water brands in Oman (Vittel, Evian and Volvic) to bring the mineral quantities in Omani and UAE water brands into perspective. According to Table 6, the percentage of DRI fulfilled for calcium by Omani and UAE bottled water brands is very low compared to imported mineral water brands. Omani and UAE brands are contributing maximum calcium DRI of 3.38 % and 3.076% respectively for adults, where as the imported mineral water brands contributing up to 18.8%. Similar results were reported in a study conducted by Ahmed *et al.,* (2016) in Bangladesh. Calcium intake of humans exceeding 1,000 mg / day may increase blood calcium levels coupled with high intakes of vitamin D and high calcium intakes results kidney stones in humans (Baker *et al.,* 2006). Current levels of calcium in Oman and UAE bottled water brands are well below Tolerable Upper Intake Limit (UL) that pose known risks to human health. Interestingly Omani brands contributing DRI of Magnesium for adults on par with imported mineral water brands (Table 6). Healthy adult men are generally expected to consume 400 to 420 mg of magnesium daily. Healthy adult women are expected to consume 310 to 320 mg a day. Pregnant women require a higher dose than women who aren't pregnant and excess magnesium present in healthy individuals is eliminated by kidneys along with urine (Musso, 2009). Bangladesh study (Ahmed *et al.,* 2016) reported, that the local brands contribute maximum of 7.3 percent of DRI for adults from brands to magnesium. Sodium is an essential nutrient for humans. The National Research Council's "Food and

Table 5: Dietary Reference Intakes for selected nutrient minerals

Elements	RDA/AI* (mg/day)		UL(mg/day)
	Male	Female	Male and Female
Calcium	1000-1300	1000-1300	2000-3000
Magnesium	240 - 420	240 - 360	-
Sodium	1200-1500*	1200-1500*	2200-2300

(*) indicates AI values.

Table 6: Comparison of maximum % DRI of calcium, magnesium and sodium in Omani and UAE brands

Bottled water	Maximum % RDA/AI		
	Calcium	Magnesium	Sodium
Omani	3.38	13.8	3.2
UAE	3.076	8.57	1.6
Vittel	18.8	16.66	1.2
Evian	16	21.66	1.08
Volvic	2.4	6.6	2

Nutrition Board" recommends that the majority of healthy adults should consume at least 500 mg / day and that sodium intake should not exceed 2400 mg/ day. Omani and UAE bottled water brands considered in the present study are contributing maximum of 48 mg/day to 24 mg/day respectively. Based on sodium contribution food products are labelled as low sodium, very low sodium and Sodium free. Per serving low sodium food products contribute less than or equal to 140 mg, very low sodium products contributes less than or equal to 35 mg and sodium free products contributes less than 5 mg of sodium (sreedharreddy *et al.,* 2018). The maximum concentration of sodium recorded in Omani and UAE brands in the present study is 23.6 mg/L and 12 mg/L respectively. If an adult weighing 70 kg drinks two liters (about 8 glasses) daily, Omani and UAE brands shall contribute maximum of 5.9 mg and 3 mg of sodium per serving (one glass of water) respectively. Based on this Omani bottled water brands comes under very low sodium category and UAE brands comes under sodium free category. For individuals on a severely restricted Na diet (500 mg Na per day), the American Heart Association (AHA) has recommended that drinking water should contain a maximum of 20 mg/L Na. In this regard, most of Omani brands (17 out of 20 brands) and all UAE brands considered in this study are suitable for people on a severely restricted Na diet.

CONCLUSION

Water quality has always been and continues to be one of the most serious challenges for human consumption. Because there is no literature on the quality of bottled drinking water in Oman, this study characterizes 20 locally produced and 20 imported bottled water brands and quantifies their dietary nutrient contribution based on information provided on the label of the manufacturer. Following conclusions are drawn based on the results of this study: 1) Concentration levels of different chemical parameters in the studied bottled water brands, meet Omani standards as well as international bottled water quality standards; 2) All UAE brands used in this study comply with GSC 1025/2008 labelling requirements, while some Omani brands did not comply with labelling requirements; 3) Mixed Ca^{2+} -Mg^{2+} -Cl^{-} type is the most dominant water type among Omani brands, whereas calcium chloride is among UAE brands. Based on similarities in their chemical characteristics, the HCA divided Omani and UAE brands into four water groups; 4) This study shows that imported brands of mineral water contain more calcium than brands of bottled drinking water sold in Oman, while Omani brands contain more magnesium than brands of UAE. Overall, imported mineral water brands fulfil the DRI requirements better than drinking water brands sold in Oman; 5) Based on dietary sodium contribution, Omani bottled water brands are categorized as very low sodium and UAE brands are categorized as sodium - free.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

ABBREVATIONS

AHA	The American Heart Association
AI	Adequate intake
DRIs	Dietary reference intakes
EAR	Estimated average requirement
ENIDE	National survey in dietary intake
FDA	Food and Drug Administration
GSO	GCC Standardization Organization
HCA	Hierarchical cluster analysis

PAEW	Public authority of Electricity and water in Oman
RDA	Recommended dietary allowances
SASO	Saudi Arabian Standards organization
UAE	United Arab Emirates
UL	Tolerable upper intake level
WHO	World Health Organization

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