مجلة جامعة بني وليد للعلوم الإنسانية والتطبيقية
Bani Waleed University Journal of Humanities and Applied Sciences
تصدر عن جامعة بني وليد - ليبيا
Website: https://jhas-bwu.com/index.php/bwjhas/index

المجلد الحادي عشر ـــ العدد الخامس ـــ 2026 الصفحات (176- 191) ISSN 3005-3900

A comparative study to examine the impact of sunlight on the physical properties of plastic water bottles obtained from wholesale and retail outlets

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دراسة مقارنة لقياس تأثير أشعة الشمس على الخصائص الفيزيائية لقنينات المياه البلاستيكية المأخوذة من متاجر البيع بالجملة والتجزئة

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Received: 08-06-2026	Accepted: 22-07-2026	Published: 29-07-2026

الملخص

في هذه الدراسة، تم قياس الخصائص الفيزيائية للقنينات البلاستيكية المستخدمة في تعبئة المياه من المنتجات المحلية. وقد حدد الفحص ثلاثة جوانب رئيسية: الموصلية، وطيف الأشعة فوق البنفسجية المرئية، ودرجة الحموضة. كما تم أخذ وزن الزجاجات الفارغة في الاعتبار في التحليل. حيث أشارت النتائج الأولية إلى وجود اختلافات كبيرة بين العينات المأخوذة من متاجر البيع بالجملة والتجزئة، حيث أظهرت درجات الحموضة تقلبات كبيرة و الذي سيكون نتيجة لتسرب جزيئات البلاستيك من القنينات. بينما تبين أن قيم الموصلية أعلى في متاجر التجزئة منها في متاجر البيع بالجملة، مما يشير إلى تعرض المنتجات لأشعة الشمس دون حماية مناسبة، خاصة في متاجر البيع بالتجزئة التي تُعرض فيها المنتجات مباشرة تحت أشعة الشمس، و أظهرت نتائج طيف الأشعة فوق البنفسجية أيضا قيم امتصاص أعلى في متاجر البيع بالتجزئة مقارنةً بمتاجر البيع بالجملة، مما يؤكد أثر أشعة الشمس المباشر علي قنينات البلاستيك. و عند أخر القياسات و هو الوزن الحساس للقنينة، باختصار كان وزن القنينات البلاستيكية الفارغة في متاجر البيع بالتجزئة أقل منه في متاجر البيع بالجملة، مما يؤكد بشكل ثابت إلى تسرب جزيئات من البلاستيك إلى الماء قبل استهلاكه. و كل ذلك راجع إلي رداءة جودة البلاستيك المستخدم في التغليف، مما يجعله غير مناسب للاستخدام مع مياه الشرب. ويتفاقم هذا العيب مع سوء التخزين و وسائل النقل المستخدمة التي قد تكون عرضة لأشعة الشمس.

الكلمات الدالة: القنينات البلاستيكية، أشعة الشمس، الأشعة فوق البنفسجية والمرئية، الموصلية، درجة الحموضة، متاجر البيع بالجملة والتجزئة.

Abstract

In this study, an examination was conducted of the physical properties of plastic bottles utilized for ingesting water from neighbourhood merchandise. The take a look at recognized three key aspects: conductivity, UV-Vis spectrum, and pH stage. The weight of the empty bottles became additionally considered in the evaluation. The findings indicated massive disparities among samples received from wholesale and retail institutions, with pH tiers displaying vast fluctuations due to chemical leakage from the plastic bottles applied for packaging. Conductivity values were found to be higher in retail stores than in wholesale establishments, suggesting insufficient transport practices that are at risk of daylight exposure without proper protection, especially in retail outlets in which merchandise are displayed immediately beneath sunlight. The UV spectrum outcomes additionally indicated better absorbance values in retail stores as compared to wholesale, further demonstrating the impact of solar publicity. In precis, the load of empty bottles in retail became lower than that in wholesale, which indicates that nanoparticles may additionally have leaked from the plastic into the water earlier than consumption. The ordinary high-quality of the plastic utilized for packaging is substandard, rendering it unwell-applicable for touch with ingesting water. This deficiency is similarly exacerbated by using the suboptimal nature of the transportation methods hired, which might be susceptible to publicity to sunlight.

Keywords: Plastic bottles, UV-Vis, Conductivity, pH, sunlight, wholesale and retail outlets.

Introduction:

Water is mandatory to maintain life, as it plays sufficient role in physical metabolism and effective operation of cells. It is necessary that the water is devoid of taste, colour and door, as well as free from any organism or chemicals that have the ability to adversely affect human health [1], it is necessary that individuals consume high quality water to maintain optimal health and facilitate development. As claimed by [1], the existence of a reliable supply without any water is a condition for the promotion of strong health and well -being within any population. Fresh, clean water access and supply suitable for human consumption is greatly affected by anthropological activities and animal behaviour [2].

Research has indicated that extended risk of plastic containers for sunlight and heat can compromise the integrity of plastic, which can lead to release of harmful chemicals in water, such as volatile organic compounds and potentially heavy metals. These leeched elements, including phthalates, have been performed to demonstrate vital health hazards, including potential carcinogenic effects and endocrine disruption. Therefore it is recommended that water from plastic bottles which are exposed to sunlight have been avoided. Protection of drinking water is an important global challenge for public health. According to estimates by the World Health Organization (WHO), it is believed that around 1.1 billion individuals worldwide lack access to safe water. In Nigeria, it is reported that the frequency of acute water diarrheal is approximately 4.9 episodes per year, which ends in about 200,000 ambushes in children under five, resulting in an average 300 deaths per day.

As claimed by [1], increasing access to safe drinking water has the ability to achieve significant health benefits. To provide inexpensive potable water to adjust the growing population, water is commonly packed in pouches, polyethylene (PE) or polyethylene terraphhelet (PET) pre-made bags or bottles, glass containers and plastic cups. This approach is particularly prevalent in Africa, where pouches and bottled water production is considered a cost - effective and unstable safe method to provide drinking water to consumers at reasonable prices. As a result, it has emerged as one of the most widely consumed objects between both middle and upper classes in urban areas. Bottled and pouches are high demand for water, especially in busy transit areas where vendors offer various brands of these products on the roads. It is important to note that a significant number of restaurants and fast-food establishments also sell this packed water. In view of the considerable consumption of these products, it is necessary that all water brands are registered with relevant food regulatory agencies within their respective countries [3]. However, in addition to some manufacturers bypassing the standard protocols, packaged water products are subject to various conditions during packaging, transport, and storage and performance process [4].

The way portable water is stored, it has a significant impact on both its safety and its quality [4]. It states that bottled water standards are uncertain, as many producers do not strictly follow the rules set up by food safety authorities. In addition, maintenance of bottled water is mandatory in specific temperature conditions, and failure to follow these requirements can cause adequate health hazards [5]. Improper water storage and bad transfer process (Figure 1) has been demonstrated to contribute to health risks [5], as water can serve as a medium for the transmission of harmful pathogens. Research has indicated that plastic containers, especially polyethylene terefthelets, are prone to fall at high temperatures. This phenomenon can lead to release of harmful substances in water. This is particularly relevant, highlighting the normal exercise of local retailers to highlight bottled water in the sun before sale [1, 4].

Fig.1. The most common methods of transporting and storing drinking water in most Third World countries, including Libya

As presented by [6], sunlight emits ultraviolet radiation energy from sunlight that accelerates photochemical fall processes and affects the stability of light-sensitive packaging materials, such as polyethylene (PE) and polyethylene tereftlate (PET). As a result, polymers found in packaging materials used for bottled water are likely to undergo oxidative reactions when the sunlight is subjected to oxidative reactions, causing leaching of chemical substances in the water. As a result, contamination from microplastic, germs and heavy metals is prevented, resulting in both physical and chemical changes, which includes disintegration of bottled water [7], the tissues of living organisms may have significant health consequences to biochemlate the capacity of heavy metals within the tissues. The microbial quality of drinking water is one of the most important environmental factors in prevention and management of waterborne diseases in both developed and developing countries. The introduction of pathogens and opportunistic organisms in drinking water can occur through uneven handling (through contact with hands and utensils) and storage and packaging materials [8] within the distribution network also the type of plastics used.

Plastics Identification Code

The Plastics Identification Code identifies the type of plastic resin a product is made from. The Code makes it easier for re-processors to identify and separate used plastics for a range of new applications. Consistent with the waste hierarchy, single and mixed materials can be recycled into a range of new products or converted into energy.

TYPE OF PLASTIC		PROPERTIES Incl. Specific Gravity & Heat Distortion Temp.	APPLICATIONS: Virgin Grades	APPLICATIONS: Recycled grades MAJOR USE / minor use
1 PET	Polyethylene Terephthalate PET	Clear, tough, solvent resistant. Used for rigids, sheets and fibres. Softens: 55° C SG = 1.38	Carbonated soft drink bottles, fruit juice bottles, pillow and sleeping bag filling, textile fibres	BEVERAGE BOTTLES Clothing, geo-textiles, bottles for detergents etc., laminated sheets, clear packaging film, carpet fibres
2 HDPE	High Density Polyethylene HDPE	Hard to semi-flexible, waxy surface, opaque. Softens: 60° C SG = 0.96	Crinkly shopping bags, freezer bags, milk bottles, bleach bottles, buckets, rigid agricultural pipe, milk crates	FILM, BLOW MOULDED CONTAINERS Agricultural pipes, pallets, bins for compost and kerbside collections, extruded sheet, moulded products, crates, garden edging, household bags, oil containers, pallets.
3 V	Unplasticised Polyvinyl Chloride UPVC	Hard rigid, can be clear, can be solvent welded Softens: 70° C SG = 1.40	Electrical conduit, plumbing pipes and fittings, blister packs, clear cordial and fruit juice bottles	PIPE, FLOORING Pipe and hose fittings, garden hose, electrical conduit, shoes, road cone bases, drainage pipes, electrical conduit and ducting, detergent bottles
	Plasticised Polyvinyl Chloride PPVC	Flexible, clear, elastic, can be solvent welded Softens: 70° C SG = 1.35	Garden hose, shoe soles, cable sheathing, blood bags and tubing, watch straps, rain wear	
4 LDPE	Low Density Polyethylene LDPE Linear: LLDPE	Soft, flexible, waxy surface translucent, withstands solvents Softens: 40° C SG = 0.92	Garbage bags, squeeze bottles, black irrigation tube, stretch and shrink films, silage and mulch films, garbage bins	FILMS: BUILDERS, CONCRETE LINING and BAGS Agricultural pipe, nursery & other films
5 PP	Polypropylene PP	Semi-crystalline, wide property and application range. Translucent (can be transparent), hard, flexible, good chemical resistance, low SG. Softens: 80° C SG = 0.90	Film, carpet fibre, appliance parts, crates, automotive applications, toys, pails, housewares / kitchenwares, bottles, caps and closures, furniture, plant pots.	CRATES, BOXES, PLANT POTS Compost bins, garden edging, irrigation fittings, building panels
6 PS	Polystyrene PS	Clear, glassy, rigid, brittle, opaque semi-tough, melts at 95°C. Affected by fats and solvents. Softens: 85° C PS = 1.05	Refrigerator bins & crispers, air conditioner, office accessories, coat hangers, medical disposables. Meat & poultry trays, yoghurt & dairy containers, vending cups	INDUSTRIAL PACKAGING, COAT HANGERS, CONCRETE REINFORCING CHAIRS Moulded products, coat hangers, office accessories, spools, rulers, video cases and printer cartridges
	Expanded Polystyrene EPS	Foamed, light weight, energy absorbing, heat insulating Softens: 85° C SG = 0. 92	Drinking cups, meat trays, clamshells, panel insulation, produce boxes, protective packaging for fragile items	PRODUCE BOXES Waffle pods for buildings, building and picture frame mouldings
7 OTHER	OTHER : Includes all other resins and multi materials (eg laminates). Eg acrylonitrile butadiene styrene (ABS), acrylic, nylon, polyurethane (PU), polycarbonates (PC) and phenolics.		Automotive, aircraft and boating, furniture, electrical and medical	AGRICULTURAL PIPING Furniture fittings, wheels and castors. Fence posts, pallets, outdoor furniture and marine structures

PLASTICS: A VALUABLE RESOURCE – EVERY TIME

The complete Plastics Identification Code of Practice is available from PACIA: www.pacia.org.au

PACIA

Fig.3. Plastics Identification Code

The purpose of this research is to employ ways of assessing health risks, including heavy metal consumption (add), target threats k As displayed in relevant literature, these health risk evaluation methods have been effectively used at a global level to estimate health risks associated with oral consumption of contaminated water [9,10]. While per-study [1, 4, 5, 11] has examined the concentration of heavy metals, which is metabolically Shorthorn Frankfurter There is denseness. To evaluate the health results of consumption of bottle water coming in contact with sunlight. The purpose of the current study is to address a significant research difference in the field. This fundamental function is paramount to evaluate health risks, especially in terms of increasing discourse around the lack of plastic production or prohibition [12-14]. In addition, due to prolonged exposure to sunlight, the ability to bottled water from plastic from chemicals and underlines the importance of conducting this study to carry forward serious health risks for consumers, with the aim of ensuring global health stability. The purpose of this research is to assess the quality of bottled water coming in contact with sunlight, and the following objective has been identified: the changing physical properties as a result of exposure to sunlight [15-17].
The main issue that this research deals with is the lack of studies in Libya that directly measure how sunlight affects the physical properties of water bottles. To address this lack of knowledge, it is important to closely monitor how water companies handle plastic. This will help us understand how the quality of plastic affects the safety of water bottles. The goal of this study is to understand how sunlight affects the physical properties of plastic bottles, such as their weight, pH level, electrical conductivity, and how much UV light they can block. This investigation will entail a careful examination of the change in these properties that occurs when they are exposed to sunlight during the process of being moved from primary sales warehouses to individual sales outlets.

Methodology

In this section, drinking water samples were collected from 16 local bottled and sold drinking water companies (i.e., from within Libya). The samples were of equivalent size, with a volume of 500 ml. The following companies are included in the study:

Table.1. Shows the names of the water companies used in the study, along with pictures of the plastic bottle and the code for the type of plastic used by each company.

NO	Manufacturer's Name	Company bottle photo	Production place	Industrial Code
1	Al-Naba		Qasr Bin Ghashir	
2	Diyafah		Misrata	
3	Ocean		Tripoli	

4	Aquasila		Tajoura - Tripoli	2 HDPE
5	Aquafina		Tripoli	2 HDPE
6	eNO		Nawfaliyeen - Tripoli	2 HDPE
7	Ojeen		Tajoura - Tripoli	2 HDPE
8	Amazon		Tripoli	2 HDPE
9	balvo		Zliten	2 HDPE
10	Hala		Misrata	2 HDPE

11	Dajla		Wadi Al-Rabee - Tripoli	2 HDPE
12	Rest		Zliten	2 HDPE
13	Sultan		Janzour	2 HDPE
14	Shaima		Misrata	2 HDPE
15	Marmara		Misrata	2 HDPE
16	NAMAR		Sebha	2 HDPE

The equipment utilized in this study includes a pH meter, a conductivity meter, an ultraviolet spectrometer, and a sensitive weight gauge.

These are among the most common methods used to monitor the condition of the plastic used for bottled drinking water and to observe the bottle's physical state before and after use [12-17].

Results & Discussion

In this section, a substantial set of laboratory results was obtained for the purpose of studying and discussing the physical properties of these bottled drinking water manufacturers. The study commenced with the measurement of the pH level to ascertain any fluctuations in it from main retail outlets to individual retail outlets. The following observations were made:

Table.2. shows the results of the pH values of the water samples from wholesale and retail stores compared to the pH values recorded on each bottle.

NO	Manufacturer's Name	Data recorded on the bottle	Wholesale outlets	Retail outlets
1	Al-Naba	7.5 – 6.5	6.75	6.95
2	Diyafah	8.5 – 6.5	6.63	6.59
3	Ocean	7.4-6.9	5.77	5.65
4	Aquasila	7-6.5	7.21	7.33
5	Aquafina	7-6	6.07	6.41
6	ENO	7.5-6.5	6.60	6.63
7	Ojeen	7-6.5	6.22	6.24
8	Amazon	7-6.5	6.28	6.45
9	Balvo	8-6.5	6.61	6.15
10	Hala	6.9	6.40	6.45
11	Dajla	7-6.5	6.67	6.43
12	Rest	7-6.5	6.37	6.45
13	Sultan	7-6.5	6.18	7.73
14	Shaima	7.4-6.8	6.47	6.66
15	Marmara	6.9	6.49	6.57
16	NAMAR	7-6	5.46	6.10

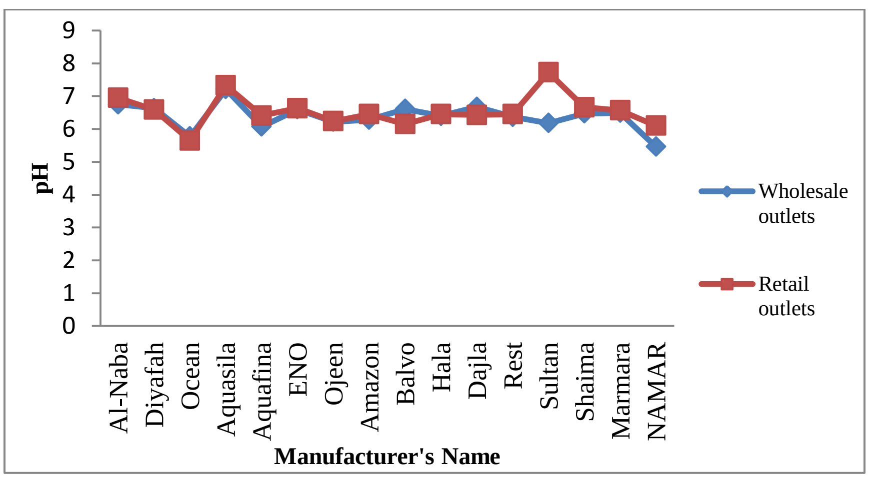

Fig.4. shows the graph comparing the pH values of water samples from wholesale and retail outlets

As demonstrated in Table No. (2) and Figure (4), there is a discrepancy in the pH levels between wholesale and retail stores. Preliminary observations indicate that a subset of the samples exhibited low pH levels following their transfer from wholesale establishments to retail outlets. Conversely, other samples demonstrated elevated pH levels. This finding serves as substantiated evidence and validation of the observed disparities in the composition of the compounds that infiltrate the water. The most prominent of these compounds, as previously highlighted in the aforementioned studies, are the most prevalent.

Table.3. Shows the results of the conductivity values of water samples from wholesale and retail stores compared to the conductivity values recorded on each bottle.

NO	Manufacturer's Name	Data recorded on the bottle, T.D.S	Wholesale outlets, T.D.S	Retail outlets, T.D.S
1	Al-Naba	110-100	75	175
2	Diyafah	200-100	40	45
3	Ocean	50-40	50	80
4	Aquasila	120-100	45	70
5	Aquafina	110-100	80	185
6	ENO	120-100	80	150
7	Ojeen	110-100	50	55
8	Amazon	120-100	25	30
9	Balvo	120-100	60	130
10	Hala	130-100	85	155
11	Dajla	100-90	65	95
12	Rest	120-100	70	55
13	Sultan	500-100	85	175
14	Shaima	130-100	65	110
15	Marmara	130-100	80	80
16	NAMAR	50-40	25	90

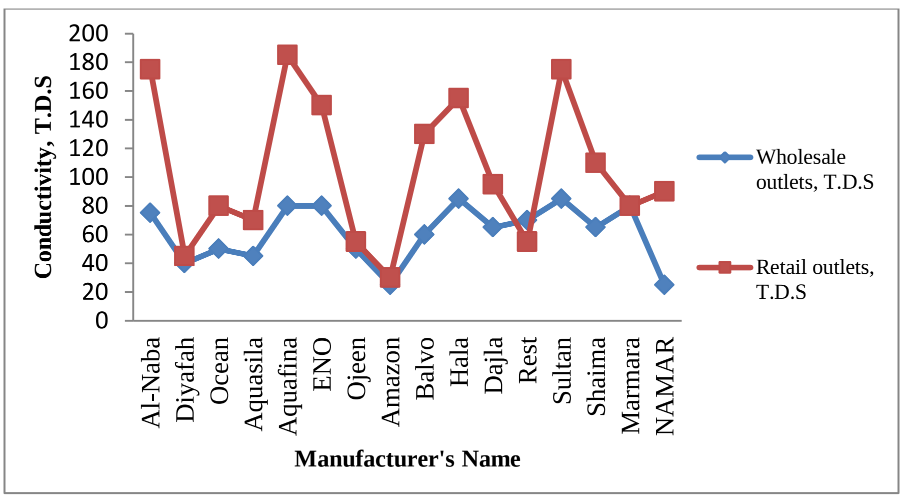

Fig.5. Shows the graph comparing the Conductivity values of water samples from wholesale and retail outlets

The conductivity measurements presented in Table (3) and Figure (5) indicated that the majority, if not all, of the results from individual retail outlets exceeded those from wholesale outlets. This finding provides definitive evidence that the plastic utilized by these manufacturers was exposed to sunlight during its transportation or due to inadequate storage and handling practices. Higher conductivity values indicate increased leaching of salts from the plastic into the bottled water.

Table.4. Shows the results of UV-vis values of water samples from wholesale and retail stores.

NO	Manufacturer's Name	Data recorded on the bottle, nm	Wholesale outlets, nm	Retail outlets, nm
1	Al-Naba	----	209	261
2	Diyafah	----	214	241
3	Ocean	----	262	296
4	Aquasila	----	209	225
5	Aquafina	----	236	263
6	ENO	----	261	295
7	Ojeen	----	222	229
8	Amazon	----	201	241
9	Balvo	----	274	290
10	Hala	----	280	300
11	Dajla	----	223	226
12	Rest	----	227	285
13	Sultan	----	231	277
14	Shaima	----	241	292
15	Marmara	----	205	234
16	NAMAR	----	210	253

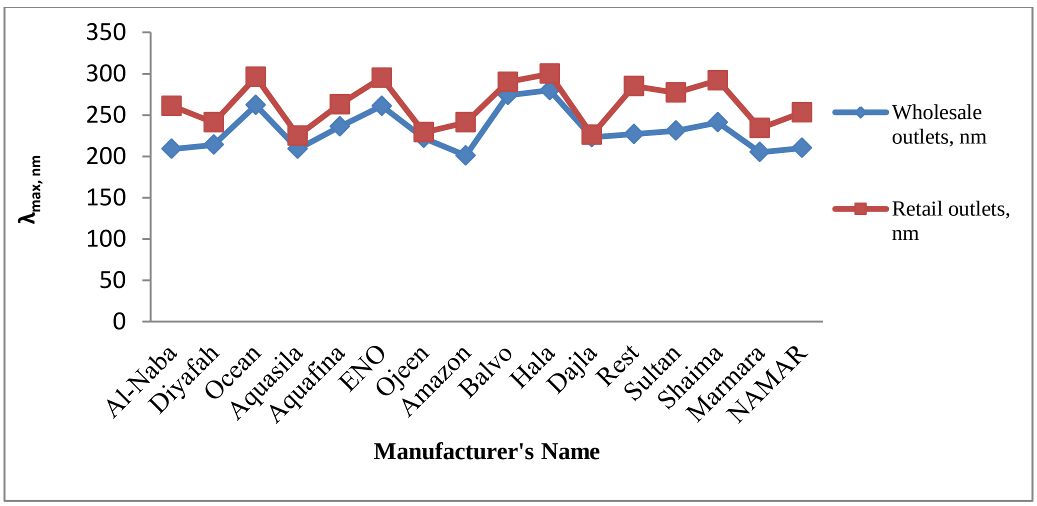

Fig.6. Shows the graph comparing the UV-vis spectrum of water samples from wholesale and retail outlets

The results of measuring the UV-V is spectrum are shown in Table No. (4) and Figure (6). It was observed that the results of the individual retail stores' samples were higher than the results of the wholesale stores. This is conclusive evidence of the effect of sunlight on all the plastic used by these manufacturers.

Table.5. Shows the results of weighing empty bottles for water samples from wholesale and retail stores.

NO	Manufacturer's Name	Data recorded on the bottle, gm	Wholesale outlets, gm	Retail outlets, gm
1	Al-Naba	----	13.3371	13.1272
2	Diyafah	----	11.7124	11.2755
3	Ocean	----	12.3711	12.3067
4	Aquasila	----	11.9688	11.5950
5	Aquafina	----	13.0486	13.0195
6	ENO	----	11.8770	11.7697
7	Ojeen	----	12.3495	12.2440
8	Amazon	----	13.2111	12.8980
9	Balvo	----	13.7076	13.6302
10	Hala	----	12.1616	11.7240
11	Dajla	----	11.9332	11.6865
12	Rest	----	13.2600	13.1646
13	Sultan	----	11.8251	11.7488
14	Shaima	----	11.7697	11.5893
15	Marmara	----	13.2071	12.2995
16	NAMAR	----	13.3500	13.1641

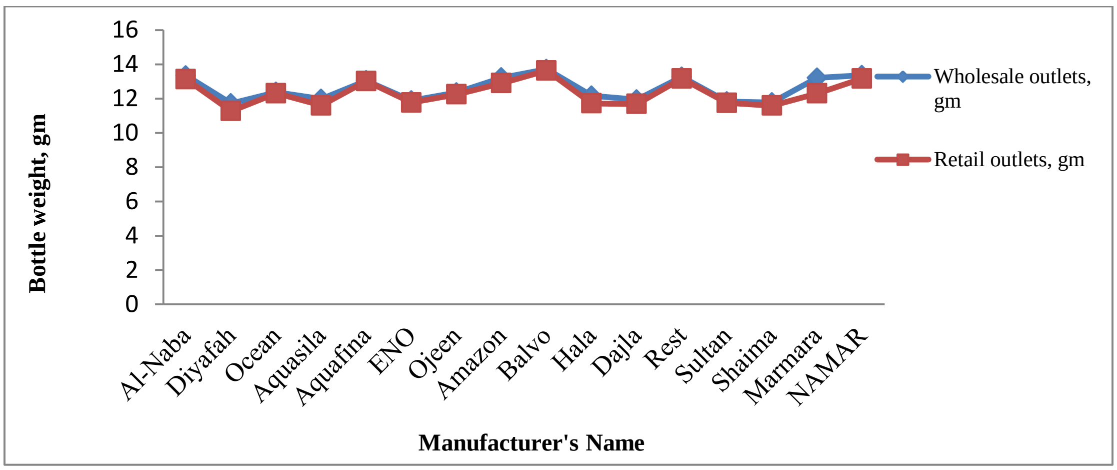

Fig.7. The graph shows a comparison between the weight values of empty bottles for water samples from wholesale and retail stores

Finally, the results of the weight measurement of the empty water bottles from each company were analyzed. The results, as presented in Table (5) and Figure (7), demonstrate a discrepancy in the weight of empty bottles between wholesale and retail stores. A decrease in weight was observed in retail stores compared to wholesale stores, which serves as additional conclusive evidence of the negative impact of poor storage and handling. This is attributed to the majority of the samples being exposed to sunlight, which in turn affected the drinking water. The substandard quality of the plastic used is also a contributing factor.

Consequently, the weights of the plastic bottles will be presented in Tables (6) and (7), which are currently empty in the appendix. This will serve to enlighten researchers and the proprietors of the aforementioned enterprises on the sensitive scale, thereby facilitating clarification and serving as a reference point.

Conclusion

The examiner discovered that the bodily characteristics of bottled water, inclusive of pH, conductivity, UV spectrum, and bottle weight, were drastically suffering from insufficient managing, storage, and publicity to daylight. The examiner identified disparities in pH stages among wholesale and shops, suggesting the capacity for chemical leaching from plastic bottles. Conductivity levels have been determined to be increased in stores, suggesting the capacity for transportation-associated troubles, particularly in times of sun publicity for the duration of transit. UV absorption exhibited a marked increase in retail locations, thereby reinforcing the effects of sunlight. Furthermore, empty bottle weights were found to be lighter in retail settings compared to wholesale, indicating potential leakage of nanoparticles from the bottles into the water prior to consumption.

The findings indicate that the type of plastic utilized is of substandard quality and poses a health risk when used for drinking water. Additionally, the transport vehicles were found to be deficient in several respects. Most notably, these vehicles frequently lacked adequate seals, which resulted in exposure to the sun, particularly during periods of high temperature. Furthermore, certain sales outlets have been observed to expose bottled water to sunlight in outdoor locations.

Recommendations

This study puts forth a series of recommendations for the drinking water industry. The study proposes the adoption of glass or a high-quality type of plastic for water storage as an alternative. The study underscores the significance of safeguarding each product batch from sunlight exposure by employing protective coverings, such as paper and reinforced wrapping. Furthermore, the study suggests the utilization of specialized vehicles equipped with covered boxes during transportation to ensure the product's integrity. The design of these boxes should prioritize the protection of the product from sunlight exposure, while also incorporating a cooling system to ensure the integrity of the water quality. Furthermore, the study emphasizes the importance of the values inscribed on the label of each bottle and underscores the necessity to elucidate the most salient physical quantities, such as pH, conductivity, and ultraviolet absorption spectrum. The study calls for the periodic monitoring of companies and the quality of the plastic used in packaging to ensure compliance with safety and quality standards.

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Table.6. shows the experimental results of weighing empty water company bottles on the sensitive scale from wholesale stores.


OHAUS
GA110
12.2444 g


OHAUS
GA110
13.2111 g


OHAUS
GA110
13.3076 g
balvo


OHAUS
GA110
12.1318 g


OHAUS
GA110
11.9332 g
DAJLA


OHAUS
GA110
13.1646 g

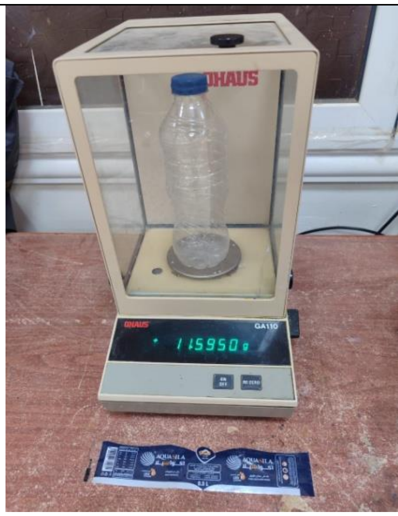

OHAUS
GA110
سلطان
SULTAN


OHAUS
GA110
11.7691 g
SHAIMA


OHAUS
GA110
13.2071 g
marmara

Table.7. shows the experimental results of weighing empty water company bottles on the sensitive scale from retail stores.



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