Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

Sampling Frequency For Water Consumption In Al-Huson Region-Jordan

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Access to safe drinking water is critical to health and development issues, and drinking behavior reflects awareness of health and water quality. In this paper, a study on the observations of trends in water consumption was conducted. hypotheses were formulated based on: water consumption, drinking tap water, awareness on drinking water, and Willingness to buy and use recycled water. To evaluate the proposed hypothesis, a baseline survey was conducted in Al Huson area in Irbid Governorate, and the representative sample of 338 was calculated based on the population projections of the Jordanian Department of Statistics for the region. The survey of the questionnaire was conducted in October 2022 to gain a better understanding on the observations of trends in water consumption.

The results showed that about half of the targeted sample (49.1%) know the amount of water they consume at home, 78.7% never drink tap water without a filter. At the same time, 60.95% of the targeted sample never drink tap water with a filter. The majority of the representative sample agreed that they prefer bottled water based on taste 77.5%, quality certificates 73.96% and composition 71%.

The results showed that 36% of the targeted samples do not trust the Water Company in their area to deliver high quality drinking water, while 71.6% agreed that the main reason for the decline in water quality is the presence of unmonitored solid waste disposal sites. 46% signify that they get information about drinking water from the Internet, while only 20% get this information from Water Company. on the other hand, 86% do not know where to ask for addressing problems related to drinking water. About one third (30%) neutrality response from the participants toward buying food from a farm that uses recycled water for irrigation, while complete approval and complete rejection took very low close proportions, of 16% and 18% for full approval and ultimate refuse respectively.

Index Terms—Drinking behavior, Recycled water, Water consumption, Water quality.

I. INTRODUCTION

The rising demand for water resources due to global population growth and resource-intensive economic development is not being adequately met by the existing infrastructure in many countries. Furthermore, Jordan is extremely susceptible to the effects of climate change, which not only decreases the availability of water but also exacerbates water scarcity through the introduction of greater unpredictability to water resources [1]. Efforts are underway to address this concern through investigations of alternative water sources, including reclaimed and desalinated water, rainwater, and wastewater reuse [2].

Nevertheless, the utilization of these alternatives requires a meticulous assessment of crucial factors, including cost and water quality [2, 3]. However, United Nations Goal 6: Ensure access to water and sanitation for all, considers that access to safe water, sanitation and hygiene is the most basic human need for health and well-being, and efforts should be developed focusing on the sustainable management of water resources. Therefore, the primary focus of developed and most developing nations lies in ensuring access to clean water, prioritizing it above other concerns, although, the commitment to prioritize is not consistently reflected in the allocation of long-term support resources by the relevant water authorities. In several cases, the issue of water quality and scarcity has been overlooked [4].

Efforts of water authorities are directed to provide water of high quality to consumers; according to the recent EU Drinking Water Directive 2020/2184, water authorities should adopt long term awareness campaigns for communicating to the consumers information about water properties, while at the same time to implement measures for reducing the use of bottled water. Nevertheless, in cases of low tap water availability and quality, citizens are usually turned to the consumption of bottled water, although it has known problems, such as higher cost than tap water and less good sustainable oversight. Bottled water in addition, has a greater environmental impact due to high energy demand process for production, bottling and transportation than tap water, as well as due to the bottling itself usually into polymeric bottles. Further, bottled water can harm public equity by exacerbating differences in safe water access between wealthy and low-income individuals.

Due to the corresponding impacts such as social inequalities and environmental ones, water authorities are encouraged to develop appropriate actions for reducing bottled water and increasing tap water consumption [5]. Under this framework, the understanding of those behavioral reasons that drive towards the choice of tap or bottled water is crucial and can support the preparation of a plan by the water agencies towards the enhancement of tap water use. However, different populations encounter local socioeconomic, cultural, demographic and environmental factors that can reduce tap water preference [6]. Local surveys can aid in understanding the specific concerns and behaviors of a target population, resulting in more effective methods to increase tap water use [7].

Jordan is globally categorized as one of the most economically disadvantaged nation in terms of renewable freshwater resources, with an average per capita water availability of approximately 61 cubic meters in 2021 much lower than the corresponding average water resources for EU Member States, accounting to about 4-5 thousand m^3 per inhabitant. In water-rich countries an inhabitant's share can be as high as around 30 thousand m^3 (Croatia) or even

more than 60 thousand m³ as in Norway. Freshwater resources in Jordan are allocated to the following uses: 47.5% for residential needs, 48.6% is utilized in agricultural activities, 3.3% is employed for industrial use, and 0.6% is designated for various purposes [8].

Political, social, and environmental issues are all involved in Jordan's water scarcity problem, making it a challenging management problem. With just 1 billion cubic meters of water allotted annually, Jordan has enormous obstacles in meeting the nation's social, environmental, and economic target [9]. In addition, Jordan's water scarcity is anticipated to worsen because of climate change. Maintaining Jordan's political and economic stability depends critically on securing a consistent supply of high quality water [10].

The aim of this work is to identify the basic parameters that drive the consumers behavior in a specific city in Jordan towards the selection of bottled and tap water and the potential links to their environmental awareness, as well as to their willingness to contribute to water conservation actions.

A. Study area

Al-Huson is a town in the north of Jordan, with a population of 35,085. It is located 7 km (4 mi) south of Irbid (Fig 1), which is the second largest governorate in Jordan (after Amman). Geographically Al-Huson is about twenty kilometers far from the Syrian Jordanian border; it is also close to the Jordan River at the borders of Palestine with many important tourist and commercial centers nearby. As a result, water sources play a crucial role in providing the population with the necessary supply for domestic, agricultural, and industrial uses.

Figure 1: Geographical location of Al-Huson within Jordan

The main water source in Irbid is the Zarqa River, which is located about 30 km south of the city. The Zarqa River is fed by several tributaries, including the Yarmouk River and the Hasa River. The Zarqa River is considered as one of the most important water sources in Jordan, providing around 70% of the country's water supply [12]. In addition to the Zarqa River, Irbid also relies on groundwater as a secondary water source. Groundwater is mainly

extracted from the Disi Aquifer, which is located in the southern part of the country [13].

However, the water source in Irbid is facing multiple challenges due to increasing population and urbanization, that result to a decline in water quality and quantity [11]. Zarqa River is heavily polluted by the uncontrolled discharge of semi-treated or even untreated industrial and agricultural effluents [12]. In addition, the increasing demand for water has led to over-extraction of groundwater, which resulted in a simultaneous decline in water quantity [13]. In addition, climate change has already affected water sources in Irbid, as a result of a decrease in precipitation associated to an increase in evaporation rates due to the corresponding temperature increase [14][15].

The primary use of Al-Huson water is for domestic consumption. According to a study conducted by the Water Authority of Jordan (WAJ) in 2018, domestic water consumption in the city was found to be around 165 liters per capita per day (L/c/d). This is significantly higher than the national average of 130 L/c/d and is attributed to the city's high population density and lack of water conservation measures [16].

In addition to domestic use, a great part of Al-Huson water is used in agricultural activities. The city is in a semi-arid region, and irrigation is essential for the cultivation of crops such as wheat, barley, and vegetables. The WAJ study revealed that agricultural water consumption was around 5 million cubic meters per year (MCM/yr). This is a significant amount, considering that agriculture accounts for around 80% of water consumption in Jordan as a whole [17].

Industrial water consumption in Al-Huson is rather less significant, accounting to about 2.5% of total water consumption in the city as reported in the WAJ; this water amount is consumed in the industrial plants around the city, involving some high water demanding units, such as textile and food processing ones [8] [17].

II. METHODOLOGY

Data aiming to identify the willingness of citizens on the use of bottled than tap water were gathered through personal interviews based on a fully structured questionnaire, designed specifically for this research. The questionnaire consists of five parts: the first part includes questions regarding consumers' choice of drinking water, tap or bottled. The second part consists of questions related to consumers' opinions about the drinking water quality in their region. Next, the third part includes questions about consumers' knowledge, education, and awareness on drinking water and environmental issues. The fourth part consists of questions regarding consumers' willingness to use and pay for recycled/reused water, while the fifth part includes questions regarding consumers' psychographic and personal information such as gender, education, income, occupation etc.

This research was conducted in Al Huson area in Irbid Governorate, and a representative sample of 338 inhabitants was calculated based on the population projections of the Jordanian Department of Statistics for the region, and using the equations of Raosoft on determining the random sample size (www.raosoft.com/samplesize), considering a 95% confidence level (a = 0.05) with the margin of acceptable error at 5%. The sampling unit was one person from each household and sample units were selected randomly. During the sampling process, gender representation, nationalities, and age groups were considered.

Personal interviews were contacted by a team of interviewees that were trained prior to the distribution of the questionnaires. Skipping patterns were implemented among Jordanian

families to ensure a normal distribution of outputs and an appropriate scientific representation of the total population of the site. The supervisor of each team monitored data collection and ensured that quality assurance measures were in place.

Statistical analysis programs (MS Excel and SPSS) were used for data analysis and the analysis of the corresponding trends.

III. RESULTS AND DISCUSSION

A. Water Consumption

Table 1. Profile of each consumers' group regarding their ecological consciousness

Ecological Consciousness		Clusters	
		Bottled Water drinkers	Tap water (unfiltered) drinkers
Participation in environmental education programs	No	23.23%	0.8%
Desire to participate in environmental education programs	Yes	20.40%	0%
Implementation of water saving measures	Yes	20.22%	0%
Using a shower, not a bath for personal hygiene	Selected	29.41%	0%
Use water from environmentally friendly water source for household needs Rainwater collection	Yes	18.30%	0%
Reuse of treated wastewater from biological cleaning	Disagree	45.45%	0%
	Undecided	22.5%	2.5%
Gray water	Disagree	38.46%	0%

reuse at home	Undecided	28.57%	0%
Use recycled urban wastewater from a public water reuse program	Likely	40.74%	0%
	Unlikely	19.35%	0%

The questionnaire results showed that about half of the targeted sample (49.1%) know the amount of water they consume at home (for all uses). Among those who are aware of their water consumption, the usage is approximately 100 liters per day (L/d), which is significantly less than the average consumption of 160 L/d. As shown in Figure 2 the majority 78.7% of the sample population (those who participated in the survey) never drink tap water without a filter. They justified this due to concerns about water quality and safety, and that bottled water is a better alternative, as 91.1%, drink bottled water, while 62.1% uses natural sources for drinking. For drinking water consumed outside home (when traveling, in a restaurant and hotel) 85.2% never drink water from the tap without a filter and 66.9% of the targeted sample never drink tap water with a filter while the majority of the targeted sample 93.5%, drink bottled water as shown in Figure 3.

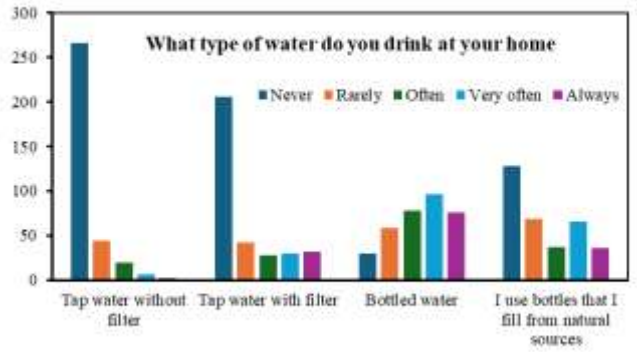

Figure 2: type of water consumed at home

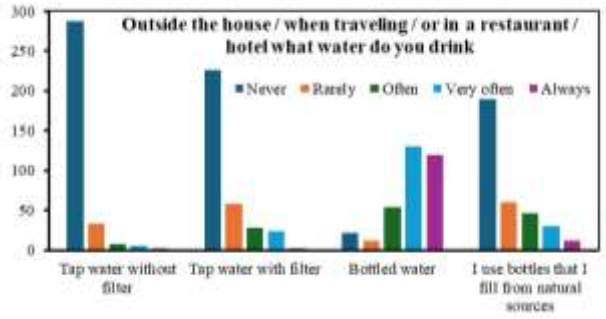

Figure 3: type of water consumed outside home

The majority of the representative sample as shown in figure 4, agreed that they prefer bottled water based on taste 77.5%, quality certificates 73.96% and composition 71%. At the same time, 27.8% of the representative sample refused to prefer bottled water, based on the comments of others. As for water preference based on the water source, brand, price, or recyclability of the packaging, most opinions were divided between approval and neutrality.

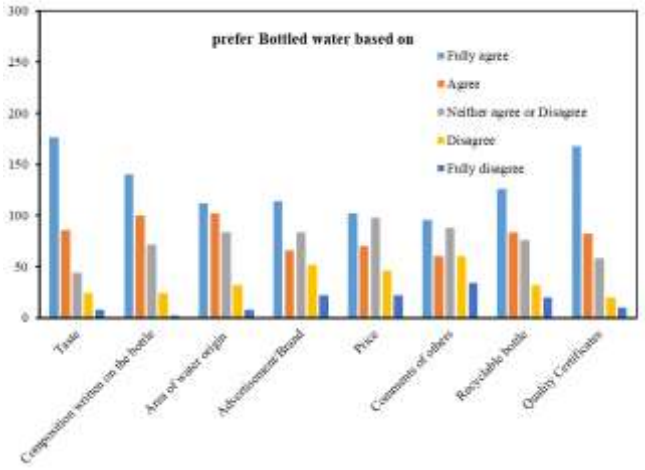

Figure 2: prefer Bottled water based on

Figure 5 shows that 62% of the targeted sample use household filter, 45% of them did not know the type of filter used, while the other 17%, use either carbon filter (9%), water desalination (7%), or a simple filter (1%). On the other hand, 38% of the targeted sample have no answer, indicating low interest in water purification methods.

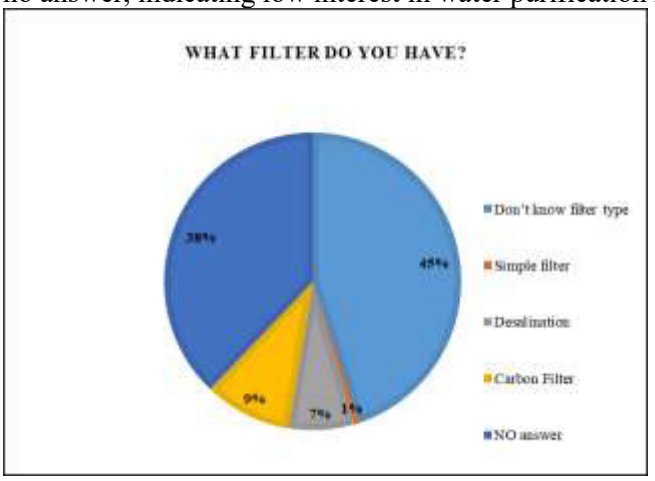

Figure 3: the percentage of household filter users

B. Specifically, for the area of Al Huson (Drinking tap water)

The questionnaire results showed that 58% of the targeted sample have a little bit trust or don't

trust at all the Water Company in their area to deliver high quality drinking water. Only 10% indicated that they trust a lot, while only 1% trusted the Water Company Very much, and 30% of the participants preferred neutrality in answering the question (Table 2).

Figure 6 shows that 71.6% agreed that the main reason for the decline in water quality is the presence of unmonitored solid waste disposal sites. While 59.2% of the targeted sample attributed the decrease in water quality to industrial activity and 55% to the use of agricultural chemicals (pesticides and fertilizers) by farmers. Most of the targeted sample were confused between agree or disagree regarding tourist activities impact on water quality.

Table 2: trust the area Water Company to deliver high quality drinking water:

Not at all	**78**	**23%**
A little bit	122	36%
Enough	102	30%
A lot	34	10%
Very much	2	1%

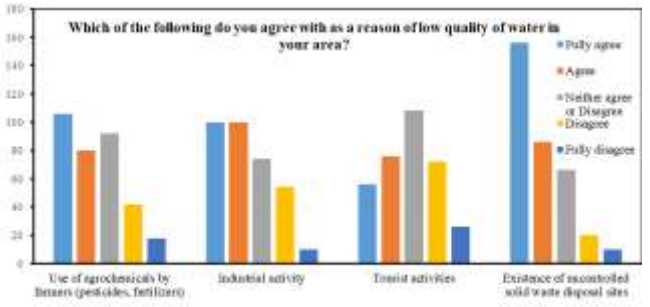

Figure 6: reasons for the decline in water quality

C. Awareness on Drinking water

The results showed that 86% of the targeted sample don't know where to ask for addressing problems related to drinking water, while 46% signify that they get information about drinking water from Internet, 30% from media and social networks, 20% from Water company and only 15% of them rely on awareness events as shown in figure 7.

The percentage of participation in environmental awareness programs was limited to 29%, which constitutes less than a third of the targeted sample (figure8), while 71% had never participated in environmental awareness programs, 60% of them expressed a desire to participate in environmental training programs on water conservation figure9, which indicates a severe shortage in these types of programs.

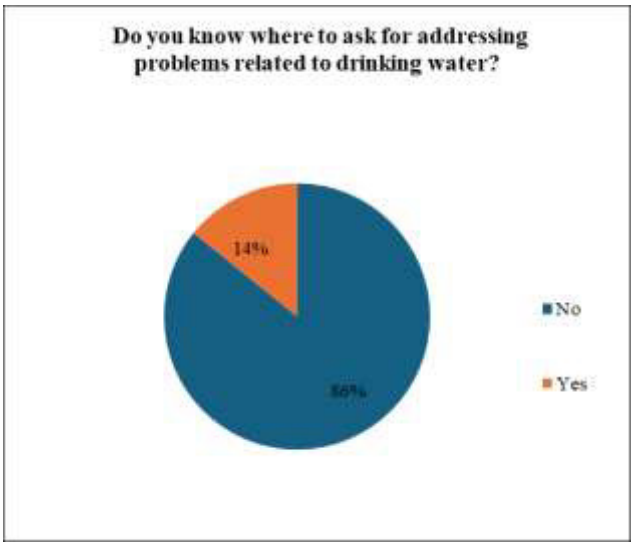

Figure 4: where to ask for addressing problems related to drinking water

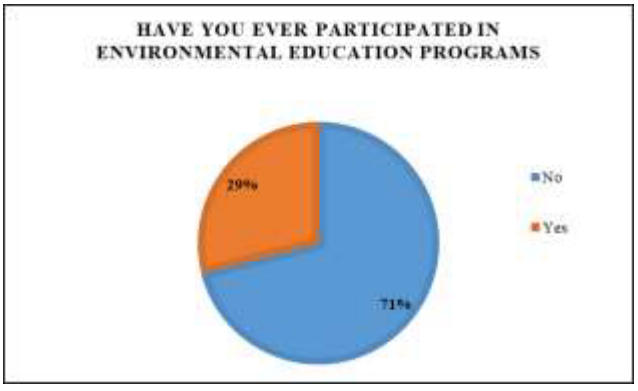

Figure 5: The percentage of participation in environmental awareness programs

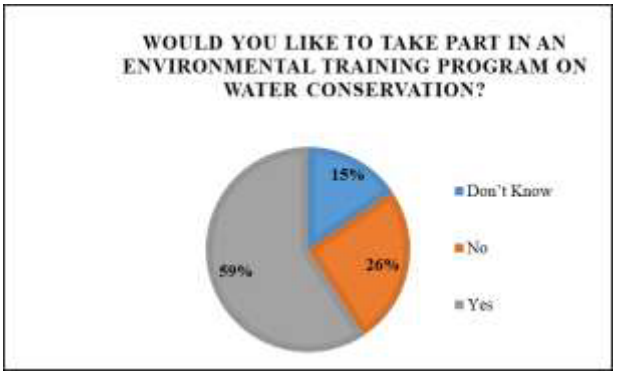

Figure 6: ability to participate in environmental training programs

D. Willingness to use and buy recycled water

178 of the participants, who represent 53% of the targeted sample, apply water-saving measures in homes, while 15% do not apply water-saving measures. The percentage of those who are not sure if they apply water-saving measure or not is 32%. The data reveals a variety of water-saving measures adopted by respondents in their households. Common practices include washing fruit in a bowl, washing cars with a bucket instead of a hose, and using dishwashing water to irrigate plants. Many respondents also wash their yards, terraces, and balconies with a bucket, highlighting a preference for methods that avoid using hoses. Harvesting rainwater is another frequently mentioned practice. Technological solutions like installing water-saving devices and using low-flow hand showers are noted, along with behavioral changes such as closing taps when not in use and paying attention to plumbing leaks. While some respondents are aware of broader strategies like wastewater treatment for agricultural use and the importance of maintaining distribution networks, a number of them expressed uncertainty, indicating a need for increased education on water conservation. Overall, the data shows a proactive approach to water-saving at the household level, with room for further awareness and education.

Figure 10 shows results about the sources of water used for laundry, garden watering, and car washing, (63.1%) agreed on using rainwater harvesting and (58%) on using gray water reused at home for laundry, garden watering, and car washing. However, out of the three options, the reuse of treated wastewater from biological treatment plants received the least amount of support, despite a sizable portion of respondents fully agreeing or agreeing. The percentage of respondents who completely disagreed with any of the water sources remained continuously low, suggesting that people are generally amenable to using non-drinking water sources, with rainwater collecting being the most popular choice.

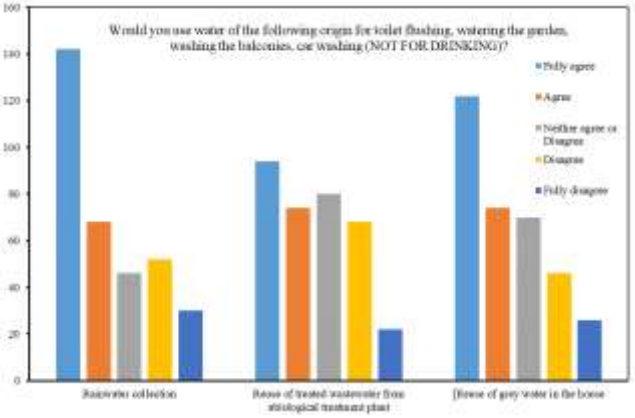

Figure 7: Using water of the following origin for toilet flushing, watering the garden, washing the balconies, car washing

Regarding the presence of wastewater treatment plants in many countries, the study showed that 45% of the sample were aware of such plants, while 38% of the participants do not know what these stations are exactly, and 17% have never heard of them [Figure 11].

As shown in figure 12, 30% of the participants showed neutral response regarding buying food from a farm that uses recycled water for irrigation, while complete approval and complete

rejection took close proportions, as 16% of the participants expressed their full approval of the purchase and 18% ultimately refused to buy food. 60% consider it unhealthy for themselves and their children.

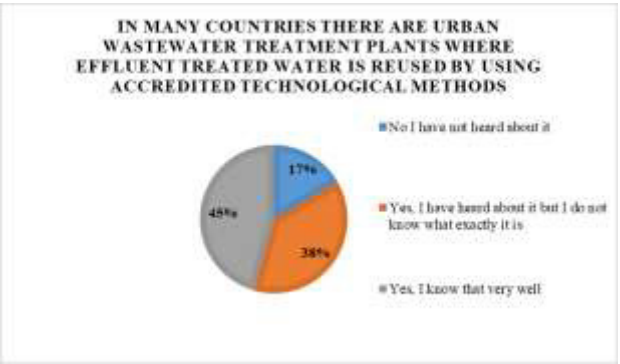

Figure 11: awareness wastewater treatment plants of

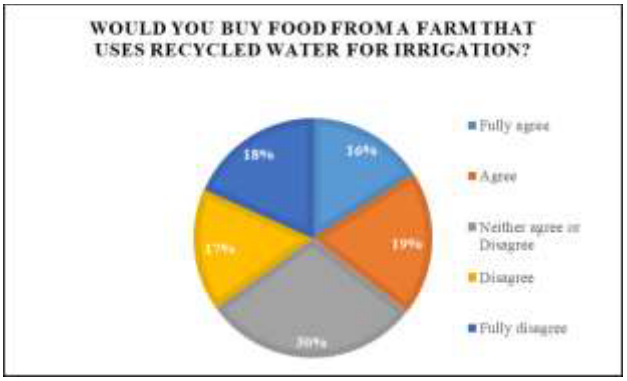

Figure 12: buy food from a farm that uses recycled water for irrigation.

The respondents broadly agreed with suggestions about learning new things, caring about environmental issues, being willing to buy more expensive food products of higher quality, and human activities destroying the planet. While consensus was small for proposing that whatever you do, the earth will not be saved.

Examining the relationships between the different aspects of the data discloses some interesting connections. For instance, there is a direct correlation between environmental consciousness and tap water drinking habits. The high percentage of individuals who prefer bottled water over tap water, regardless of whether it is filtered, suggests a heightened awareness of water quality issues and health concerns. This awareness is probably impacted by the mistrust in the Water Company and the perception of declining water quality due to unmonitored waste disposal sites. Additionally, the reliance on the Internet for information about drinking water further indicates a proactive approach to seeking knowledge, although the lack of trust in official sources highlights a gap in communication and reliability. This environmental consciousness extends to attitudes towards recycled water, with a significant

portion of the sample expressing neutrality, indicating openness but also caution in adopting sustainable practices.

The socio-demographic data of the sample population reveal a balanced gender distribution with 50% male and 50% female participants. The age of the respondents ranges from 18 to 60 years. In terms of living arrangements, 78% of the participants reside in a house, while the majority, 22% live in an apartment. Regarding educational attainment, a significant 87% of the participants have a university degree, while the remaining participants have completed other levels of education, including postgraduate, high school, and preparatory studies.

CONCLUSION

The study found that about half of the targeted sample know the amount of water they consume at home. Most of them never drink tap water with or without a filter, they prefer bottled water based on taste, quality certificates and composition. A few participants trust the Water Company to deliver high quality drinking water, while the majority have a low trust or neutral response. It was also found that the presence of unmonitored solid waste disposal sites is the main reason for the decline in water quality. Most of the participants don't know where to ask for addressing problems related to drinking water, a few of them get information about drinking water from Internet, while Minority ask Water Company. The participants didn't show tendency to approve or reject the idea of buying food from a farm that uses recycled water for irrigation.

ACKNOWLEDGMENTS

This research has been carried out with the financial assistance of the MEDiterranean QUadruple helix Approach to Digitalization (MED-QUAD) project, B_A.2.1_0088 funded by European Union under the ENI CBC Mediterranean Sea Basin Programme. The authors would like to express their sincere gratitude to the European Union under the ENI CBC Mediterranean Sea Basin Programme, Project B_A.2.1_0088_MED-QUAD for their support in facilitating this study

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