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An Assessment of Treated Greywater Reuse in Irrigation on Growth and Protein Content of *Prosopis* and *Albizia*

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Abstract: This study investigated the influence of treated greywater on growth and protein content of multipurpose (forage and ornamental) transplants, *Prosopis juliflora* L., *Prosopis tamarugo* L., and *Albizia lebbeck* L. Transplants of tested species were irrigated with treated greywater, diluted greywater (grey + distilled water, 1:1/by volume), and distilled water (control) for seven months. Water quality analysis showed that the concentrations of nutrients and heavy metals found in the greywater were within the acceptable range compared with Jordan Institution for Standard and Metrology (JISM) and the World Health Organization (WHO) thresholds for safe use of greywater. *Escherichia coli* found in the greywater were lower compared to JISM and WHO guidelines for the safe use of greywater. Irrigation with treated greywater increased shoot fresh weight by 24–39% and dry weight by 34–40% compared to diluted greywater and control. No significant difference in crude protein was noticed between water treatments. *Prosopis* species (*P. juliflora Albizia lebbeck* L. and *P. tamarugo Albizia lebbeck* L.) had higher shoot fresh (35%) and dry weight the same species had lower crude protein (44%) when compared to *Albizia lebbeck Albizia lebbeck* L. The reuse of treated greywater for landscaping or forage production alleviates the demand for water resources and reduces the pressure on wastewater treatment plants. However, considering the controversial findings of previous studies on greywater quality (especially, long-term reuse), the reuse of treated greywater needs to be considered with caution and periodic quality analyses and economic assessments are required.

Keywords: water management; ornamentals; heavy metals; legumes; protein; *Escherichia coli*

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1. Introduction

High demand for water due to the growth in population coupled with frequent drought during the last decades has encouraged governments to adopt new innovations to ensure the sustainable management of water resources, such as water harvesting and the reuse of waste- and greywater for agriculture, such as landscaping [1,2]. The use of wastewater for irrigation might present negative effects, especially environmental contamination and toxicity [3]. Wastewater contains toxic microorganisms and heavy metals, such as chromium (Cr), cadmium (Cd), nickel (Ni), lead (Pb), and mercury (Hg), which can induce severe risks to plant, human, and the environment [3]. However, rainwater harvesting, greywater recycling, and hybrid rainwater–greywater systems are less harmful to the environment and can mitigate urban water scarcity at both domestic residential dwelling and commercial building scales [1,4]. The hybrid rainwater harvesting-greywater systems had the highest mains water savings (55.3%), lowest environmental impact, and was the second-fastest system to become financially effective at USD 5.20 m^{-3} (rainwater harvesting, USD 2.00 m^{-3}) when compared to centralized mains water system [4].

Greywater is defined as wastewater from kitchen, bathroom, or laundry without any input from toilets [5]. While wastewater originating from toilets comprises a significant amount of residential waste, greywater fraction accounts for about 70% of the total residential wastewater [6]. Therefore, the investment in greywater reuse can potentially reduce wastes by converting a significant fraction of wastewater to a suitable water source [6,7]. Greywater reuse is a common practice in both developed and developing countries as a coping strategy to sustain water resources [8]. Greywater has substantial benefits for non-potable reuse applications such as irrigation and toilet flushing [9]. In fact, treated greywater is a viable approach and a potential source of water that alleviates the demand and pressure on freshwater for food production [8]. This is because most water conservation methods are ineffective, expensive, and might require expertise in addressing water challenges, specifically in developing countries.

Greywater reuse is essential for sustainable water management in arid lands, promoting the preservation of the limited freshwater resources, and reducing environmental pollution and overall input costs [10]. In the last two decades, several research studies assessed the environmental, economic, and energetic benefits of the reuse of greywater as a potential secondary source of water and represent a viable opportunity for the sustainable management of water resources [7]. Generally, all types of greywater have good biodegradability [11]. After six months of greywater (electrical conductivity (EC_W) = 1.83 dS m^{-1}, sodium adsorption ratio (SAR) = 3.3) application, soil EC was 1.8 dS m^{-1} and SAR was 3.04. In addition, leaf nutrient (nitrogen (N), phosphorus (P), potassium (K^+), sodium (Na^+), chloride (Cl^-), Cd and Pb)) from irrigated olive trees and vegetable crops (okra, bean, corn, and sunflower) were not affected [10]. A long-term study (four years) on vegetables showed that pH and Na^+ values from grey- and freshwater treatments were similar across soil profiles, 0–90 cm soil depth [11].

Prosopis and *Albizia* species are large trees or shrubs belonging to the Fabaceae family; characterized by their fast growth, N-fixation, and adaptation to poor environments, including drought, high temperatures, and nutrient-contamination, especially heavy metals [12–14]. *Prosopis* and *Albizia* are multipurpose trees used as wood, fuel, feed for livestock, landscaping (shade, fencing), and forestation [12,15]. *Albizia* species, including (*A. lebbeck* L. and *A. julibrissin* L.), has been used recently in plantscaping, including in Jordan [16]. Although Prosopis spp. can be a potential threat (invasive) to arid regions, especially under unsuitable management practices, promoting the use of these species by locals is a useful strategy toward the control of their spread and gain extra income; wood, Xeriscaping, and grazing [12,17]. In fact, the estimated wood production from *Prosopis* trees in Sweimeh, Jordan was about 675 ton ha^{-1} in the extremely invaded regions [17]. The proper use of those multi-purpose species (e.g., *Prosopis*) can contribute to socio-economic development in rural communities [12]. However, to guarantee an aesthetic appearance in the landscape or high production (wood, fuel, grazing), frequent irrigation is a prerequisite.

Several studies had investigated the use of greywater in forestry plantations and its productivity [18,19]. Forestry plantations are considered as revenue to respond to the rapid increase in biomass and energy consumption worldwide [18,20]. In fact, short rotation forestry is considered a renewable energy source, especially for rural communities and poor people in developing countries, in addition to the substantial opportunities it offers for investments at farm and community levels [18,19]. Therefore, water and nutrients supply for forestry plantations through greywater reuse is of great interest in arid lands region, including Jordan.

Jordan is among the most water-scarce countries in the world with a renewable water supply that only covers approximately half of the population's water demand [21]. Accordingly, the adoption of the greywater approach for the sustainable conservation of water in countries of the eastern Mediterranean region (including Jordan) is inevitable [2]. The objective of this study was to assess the influence of treated greywater reuse on the growth and protein content of *P. juliflora* L., *P. tamarugo* L., and *Albizia lebbeck* L.

2. Materials and Methods

2.1. Experiment Setup and Plant Material

The study was conducted in a greenhouse at the Jordan University of Science and Technology (JUST) Irbid, Jordan (long. 32°29′12.77″ N, lat. 35°59′32.38″ elev. 585 m). *Prosopis juliflora* L., *Prosopis tamarugo* L., and *Albizia lebbeck* L. were collected from JUST Arboretum and were sown in 5 L pots filled with a growing substrate composed of sandy-loam soil + peat moss (2:1/by volume). Media pH was 6.8 and EC_w was about 1 dS m^{-1}. Pots were placed on a bench table in the greenhouse. Mean temperatures, relative humidity, and light intensity during the study period were 25 °C, 50%, and 1100 µmol s^{-1} m^{-2}.

2.2. Greywater Sources and Quality Analyses

Treated greywater used in this study was from the confined trench unit developed by the JUST to reuse greywater from student dorms (Figure 1). The filtration unit consists of an impervious plastic trench filled with different sizes of gravel and a sand layer (at the base). Gravel filter media at the top layer of the unit ranged from 20 mm to 30 mm in diameter, while the lower layer was between 2 mm and 5 mm. Sand particles' size ranged from 0.05 mm to 1.0 mm. Greywater used in the study was collected from the post-treatment holding tank (treated greywater). Water quality analysis for treated greywater was conducted prior to irrigation following the procedures of Al-Hamaiedeh and Bino [10]. Quality analyses included pH, EC_w, biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), SAR, exchangeable sodium percentage (ESP), nitrate (NO_3), N, calcium (Ca^{+2}), magnesium (Mg^{+2}), K^+, Na^+, Cl^-, zinc (Zn), iron (Fe), boron (B), arsenic (As), Cd, Pb, and *Escherichia coli*.

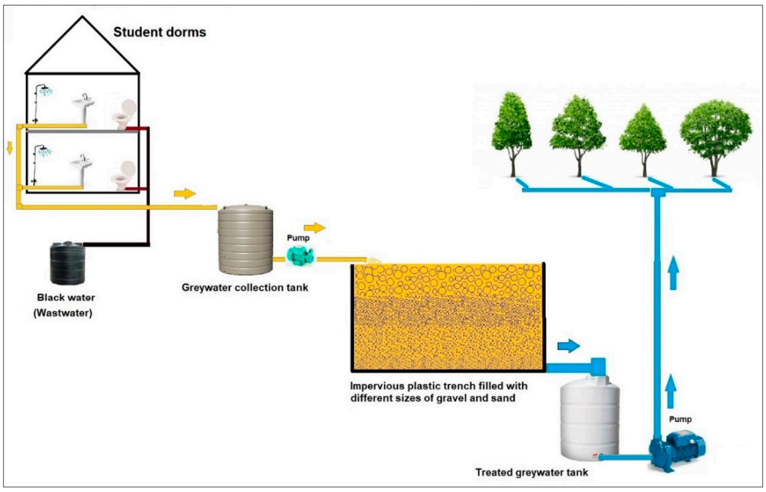

Figure 1. Schematic diagram for the greywater treatment unit.

2.3. Treatment

During the study period, the following treatments were evaluated: control (distilled water), treated greywater and a mixture of greywater, and distilled water (1:1/by volume). The experiment was designed as a complete randomized block design with three replicates. The tested species were irrigated twice a week. Tested species shoots were recut three times during the growing season (seven months). Shoot fresh and dry weight and total N were determined for each treatment and across the three cuttings. Total nitrogen was determined by the Kjeldahl Method. Shoot protein content was then derived by multiplying the N% by 6.25.

2.4. Statistical Analysis

A randomized complete block design with three replications and two factors (three water sources, three plant species) was used. The analysis of variance (ANOVA) and the least significant difference test ($p = 0.05$) in Statistical Analysis System (SAS; Version 9.3 for Windows; SAS Institute, Cary, NC, USA) were used to identify differences between water sources.

3. Results and Discussion

3.1. Greywater Quality and Plant Yield

The quality of treated greywater was assessed for reuse in irrigation according to (Jordan Institution for Standard and Metrology (JISM)) and the World Health Organization (WHO) (Table 1) [2,22]. The concentrations of nutrients and heavy metals (N, Ca^{+2}, Mg^{+2}, K+, Na+, Cl-, Zn, Fe, B, As, Cd, Pb, NO_3, PO_4), pH, EC_W, BOD, COD, TDS, ESP, and *Escherichia coli* found in the greywater were within the acceptable range compared to the Jordan Institution for Standard and Metrology (JISM) and the World Health Organization (WHO) guidelines for the safe use of greywater. The evaluation of reusing greywater in home gardens in water-limited environments showed that greywater can be reused for home gardening when diluted with fresh water [23]. This is because average pH (8–9), SAR (1–10), Soluble Sodium Percent (68–92%), and Cl^- (–30 meq l^{-1}) values from tested sites were found to be within the acceptable range [23].

Table 1. Quality of treated greywater compared with allowable Jordanian standard limit for irrigation (Jordan Institution for Standard and Metrology (JISM)) and the World Health Organization (WHO) [2,22].

Parameter	Treated Greywater	JISM	WHO
pH	7.9	6.0–9.0	6.5–8.0
EC_w (dS m^{-1})	0.7	1.0–3.0	0.7–3.0
N (mg L^{-1})	17.7	50	5–30
Ca^{+2} (mg L^{-1})	71.9	400	-
Mg^{+2} (mg L^{-1})	17.3	60	-
K^+ (mg L^{-1})	5.1	80	-
Na^+ (mg L^{-1})	43.5	230	69–207
Cl^- (mg L^{-1})	85.1	400	140–350
Zn (mg L^{-1})	0.7	2.0	<2.0
Fe (mg L^{-1})	0.1	5.0	0.1–1.5
B (mg L^{-1})	0.4	1.0	0.7–3.0
As (mg L^{-1})	<0.002	0.1	<0.1
Cd (mg L^{-1})	<0.002	0.01	<0.01
Pb (mg L^{-1})	<0.01	5.0	<5.0
BOD_5 (mg L^{-1})	12.9	60	-
COD (mg L^{-1})	29.6	120	-
PO_4 (mg L^{-1})	0.2	30	-
NO_3 (mg L^{-1})	2.0	45	50
TDS (mg L^{-1})	429	<2000	450–2000
SAR (ratio)	21.9	9.0	<13
ESP (%)	0.5	-	-
E. coli (no. 100 mL^{-1})	408	$<10^3$	10^4–10^5

EC_w, electrical conductivity; BOD, biological oxygen demand; COD, chemical oxygen demand; TDS, total dissolved solids; SAR, sodium adsorption ratio; ESP, exchangeable sodium percentage; *E. coli*, *Escherichia coli*.

Escherichia coli is a coliform group of bacteria that used to model the pathogenic bacteria in reused water and their behavior is expected to reflect enteric pathogens [2]. A long-term study (8–18 years) on the impact of greywater disposal on soil showed that greywater irrigated soils had higher pH, P, and microbial activity [24]. A pH value of 9 and *Escherichia coli* up to 10^3 MPN g^{-1} was recorded for some greywater-treated soil locations. Higher microbial activity in greywater-treated soils may be beneficial for plant growth but *Escherichia coli* levels may be a risk to human health [24]. In this study, *Escherichia coli* numbers in the treated water (408 per 100 mL) were lower than the WHO standards (10^4–10^5 per 100 mL). Therefore, *Escherichia coli* counts in treated greywater resulted in acceptable risk. Our results were similar to Disha et al. [25], who concluded that treated greywater is bacterially safe and has a positive impact on plant growth. Given that *Escherichia coli* could exceed the safe limit (long-term reuse), periodic soil and water quality test is essential when greywater is the main source for irrigation.

Irrigation with treated greywater increased shoot fresh weight by 24–39% and dry weight by 34–40% compared to diluted greywater and control (Table 2). That shoot growth increased in parallel with increased greywater ratio (control-diluted-greywater) is consistent with the results for pepper (*Capsicum annuum* L.) [25] cabbage (*Brassica oleracea* L.) and onion (*Allium cepa* L.) [26]. A higher growth rate can be attributed to higher nutrient levels in greywater water compared to control (Table 1). Nutrient levels play a key role in plant morpho-physiology such as photosynthesis, root and shoot growth, and flower and fruit quality [27–31].

Table 2. Shoot fresh and dry weight (total yield per plant) and crude protein (%) of *Prospois juliflora* L., *Prospois tamarugo* L., and *Albizia lebbeck* L. seedling grown under different water quality treatments.

Water Source (W)	Species (S)	Shoot Fresh wt. (g plant^{-1})	Shoot Dry wt. (g plant^{-1})	Crude Protein (%)
Distilled water		60.9 b	32.7 b	11.2
Distilled+greywater		68.3 b	34.0 b	11.6
Greywater		84.8 a	45.7 a	10.9
	Prosopis juliflora L.	74.4 a	39.4 a	8.80 b
	Prosopis tamarugo L.	76.6 a	41.0 a	9.00 b
	Albizia lebbeck L.	63.0 b	32.0 b	16.0 a
p-value	W	<0.0001	<0.0001	0.68
	S	0.006	0.001	<0.001
	W × S	0.08	0.13	0.89

Different letters indicate differences among treatments according to Fisher's Least Significant Difference (LSD) test ($p \leq 0.05$).

The significant increase in shoot growth is coupled normally with a reduction in nutrient and protein concentration in the tissues due to the dilution effect [32]. In this study, the dilution effect was noticed in *Prosopis* species compared to *Albizia* (Table 2). This significant increase in shoot growth of *Prosopis* seedling (35%) induced the dilution phenomena and consequently reduced protein (%) in the same tissues by 44%. Interestingly, when shoot dry weight of treated greywater treatment increased by 40% (compared to control), crude protein only reduced by 3%. Overall, irrigation with greywater potentially improved yield and feed quality (crude protein) across the experimental period (three cuttings) and over the tested species; *Prosopis* and *Albizia*.

3.2. Reuse of Greywater for Irrigation of Multipurpose Trees—Prosopis and Albizia

Prosopis and *Albizia* species have been widely used in arid and semi-arid regions for fuel, wood, feed for animals, and ornamental woody trees [16,17]. This is because these species are highly adapted to harsh environments, including drought, salinity, and soil contamination [14]. Legumes (including *Prosopis* and *Albizia*) leaves are highly digestible by grazing animals and rich in protein and carbohydrates. In addition, these species provide an attractive and aesthetical view of the landscape, especially *Albizia* species [16]. The reuse of greywater for irrigation in the urban landscape and forage production is becoming increasingly common recently, especially in arid lands [10].

3.2.1. Food and Forage Production

During the study period, *Prosopis* and *Albizia* irrigated with greywater had consistently higher shoot fresh weight (compared to control, distilled water) across the three cuts (Figure 2). Similarly, shoot dry weight from greywater was higher than control across species (Figure 3). Therefore, greywater can potentially improve crop production compared to well water.

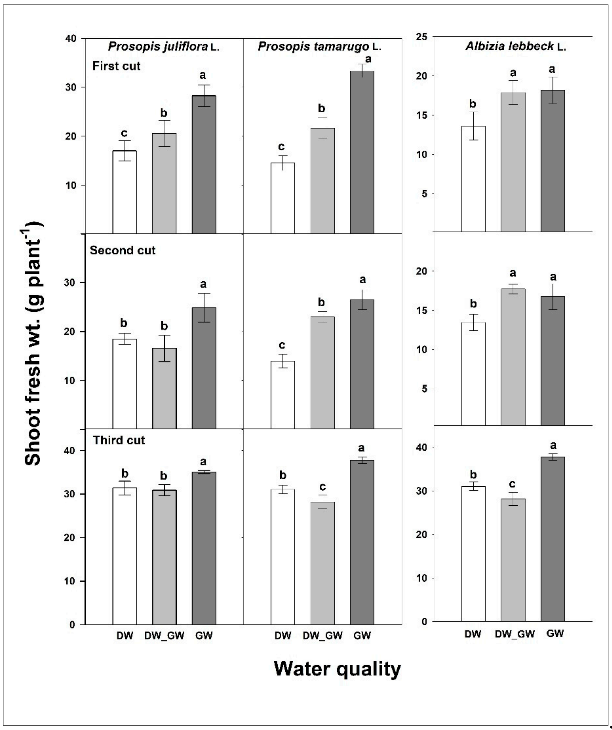

Figure 2. Fresh yield of different multipurpose tree species (*Prosopis juliflora* L., *P. tamarugo* L., and *Albizia lebbeck* L.) grown under different water quality treatment; distilled water (DW), distilled + greywater (DW_GW), and greywater (GW). Bars represent mean ± standard error (SE). Different letters indicate a significant difference between treatments ($p \leq 0.05$).

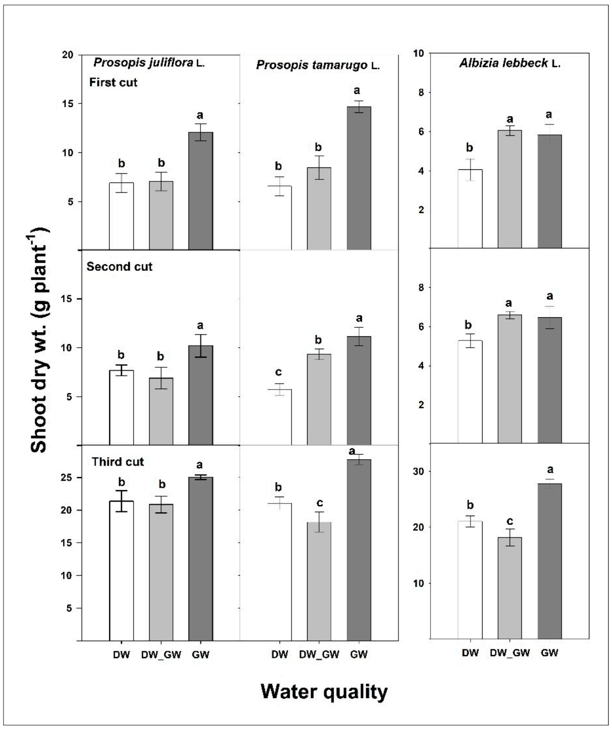

Figure 3. Fresh yield of different multipurpose tree species (*Prosopis juliflora* L., *P. tamarugo* L., and *Albizia lebbeck* L.) grown under different water quality treatment; distilled water (DW), distilled + greywater (DW_GW), and greywater (GW). Bars represent mean ± SE. Different letters indicate a significant difference between treatments ($p \leq 0.05$).

Untreated greywater normally contains higher nutrients and bacterial populations than tap water, but the treatment process reduces the concentration of most unwanted greywater parameters and brings them into irrigation standards [25]. A recent review on quality and quantity of greywater reuse showed large variations in greywater quality and quantity associated with time and source, and the filtration treatment [33]. Interestingly, that review concluded that heavy metals and organic micro-pollutants in treated greywater rarely pose a threat to human health if recycled properly. Greywater reuse, after treatment, sustains water resources by conserving irrigation water and protects the aquatic ecosystem (freshwater ecosystem) from the adverse effect of wastewater [25]. Despite these high counts of fecal coliforms (4×10^5/100 mL) and fecal streptococci (2000/100 mL) in greywater, no significant difference in contamination levels was found between crops (carrots and lettuce) irrigated (eight weeks) with greywater and tap water [34]. Shi et al. [35] assessed the microbial risk of using two greywater reuse scenarios, toilet flushing, and food-crop irrigation. They found that treated greywater from the bathroom, laundry, and kitchen could be safely used for toilet flushing. The median range of annual infection risk when using treated greywater was estimated at about 8.8×10^{-15}–8.3×10^{-11} per-person-per-year (pppy), which were within the acceptable levels of US Environmental Protection Agency (US EPA) annual infection risk ($\leq 10^{-4}$ pppy). For food-crop uses, the estimated annual infection risk greywater (bathroom and laundry) reuse was below the thresholds set by US EPA (bathroom 2.8×10^{-8} pppy, laundry 4.9×10^{-8} pppy). However, kitchen greywater source was not suitable for food-crop irrigation (4.9×10^{-6} pppy) [35].

The soil–plant–animal relationships need to be taken into account for a better understanding of metals' impact on grazing animals (e.g., cows). The bioavailability and accumulation of metals (especially, heavy metals) in vegetation are essential parameters to assess the soil–plant relationship and metal translocation to vegetation. Those parameters are governed by the adsorption capacity of the soil, which highly depends on soil pH organic matter content [36,37]. When plant roots uptake those metals and accumulate them in the vegetative parts, they become readily available for grazers. Heavy metals (Cr, Cd, Hg, Pb, and Ni) are metallic elements, have relatively higher density (heavier) than water, and are highly soluble in the aquatic environments, and therefore, they can be absorbed by living organisms easily [38]. Those metals are readily transferred through food chains and cause potential toxic effects to animal and human health [39]. In fact, heavy metals are critical bio-accumulative toxins in the dairy production system [40]. The uptake of forage containing heavy metals (e.g., Cd, Pb, and Hg) accumulates in animal organs, including liver and kidney, and exerts adverse effects on those domestic animals [41]. When animals (e.g., dairy cows) consume heavy metal-containing feed, those toxic contaminants may transfer to the food products of animal origin, such as liver, meat, and milk, and cause human health problems [42]. Although the concentrations of heavy metals found in the greywater were within the acceptable range suggested by WHO (Table 1), long-term reuse could accumulate those toxic metals in soil and plant. For example, when barely (animal feed) seedling grown in a hydroponic system containing 1.0 $\mu g\ l^{-1}$ Cd, 5.0 $\mu g\ L^{-1}$ Pb and 1 $\mu g\ l^{-1}$ Ni for 9 days, the concentration of Cd in the shoots was 54 $\mu g\ kg^{-1}$, Pb, 33 $\mu g\ kg^{-1}$ and Ni 675 $\mu g\ kg^{-1}$ [43]. Given these limitations, the reuse of greywater needs to be considered with caution.

3.2.2. Ornamentals, Fuel, and Wood Production

Prosopis and *Albizia* have been used in landscaping in the Mediterranean region, including Jordan. However, frequent irrigation is required to sustain the aesthetic appearance of those species in the landscape. Greywater has been used for irrigation landscape plants worldwide. Recently, novel ornamental green wall systems for greywater treatment have been developed to cover the aesthetic, environmental, and economic demands for urban areas [44,45]. Ornamental plant species such as *Carex appressa* L., *Nephrolepis obliterata* L., *Myoporum parvifolium* L., and *Liriope muscari* L. were adapted to greywater quality and could be used as aesthetically attractive, on-site greywater treatment system [45]. However, the reuse of greywater can lead to environmental problems such as groundwater contamination (e.g., heavy metals and *Escherichia coli*).

The characteristics and chemical composition of greywater are critical for health and environmental aspects [5]. Greywater reuse for landscaping and wood production is likely to have environmental effects, which may be positive or negative. While greywater can contain plant nutrients that may enhance plant growth, high levels of surfactants, Na+, and pathogenic microorganisms may negatively affect environmental and human health [24]. Generally, greywater is evaluated according to specific quality characteristics and standards to avoid that it poses a risk to the environment or humans [9,11]. These standards and quality criteria generally consist of chemical (heavy metals and nutrients) and microbiological parameters (pathogens). However, only specific compounds are measured and the chance of having non-measured possible toxic substances is possible [9,46]. The composition of greywater depends on sources (kitchen, bathroom, or laundry) and normally contains lower levels of organic matter and nutrients compared to ordinary wastewater [5]. In fact, greywater is highly variable in quality and may contain some pathogens such as *Aeromonas*, *Salmonella*, *Pseudomonas*, and *Staphylococcus*; consequently, it should not be reused without treatment [47]. Antibiotic and herbicide analysis in household greywater reuse systems in Palestine revealed that antibiotics and herbicides were widely found in greywater influent [46]. Off-grid greywater reuse systems did not consistently remove atrazine, ciprofloxacin, erythromycin, oxolinic acid, tetracycline, and trifluralin. Antibiotics concentration in greywater influent samples ranging from 1.3 ng L^{-1} to 1592.9 ng L^{-1} and herbicides were detected at a range of 3.1–22.4 ng L^{-1} [46]. In Australia, a total of 22 organic micro-pollutants, including acesulfame, caffeine, paracetamol, salicylic acid, and triclosan were detected in greywater, and consequently, the reuse of greywater in irrigation of ornamental trees can act as a source of organic micro-pollutants to shallow groundwater and nearby surface water [48]. Therefore, micro-organisms and heavy metals accumulations in soil and groundwater have to be taken into account when greywater is reused [5].

Onsite greywater treatment potentially reduces heavy metals levels, and therefore, those metals should not pose a problem for reuse in toilet flushing or irrigation [49]. However, the essential environmental problems associated with the existence of those toxic metals in greywater are linked to the issue of sludge disposal [49]. Turner et al. [50] compared the accumulation levels of metals in soil, groundwater, and surface water, as a result of greywater reuse in irrigation to national and international guidelines. They found greywater reuse gradually increased soil As, B, Cr, and Cu and exceeding guidelines after only four years of irrigation. In addition, leaching of metals from the grey-irrigation soil resulted in metal concentrations (Al, As, Cr, Cu, Fe, Mn, Ni, and Zn) in groundwater exceeding environmental quality guidelines after four years. Although the results of Turner et al. [50] are unlikely to be applicable worldwide, the results indicate the necessity to consider metals in greywater in order to reduce the adverse environmental impact from greywater irrigation.

3.3. Ways for Improvement

A reduction in residential water demand can be achieved by improving water supply systems, raising public awareness about water-saving, and reusing, specifically, greywater [6]. In fact, the adoption of greywater for the sustainable conservation of water is inevitable, especially in drylands. Some communities are cautious about greywater reuse for irrigation due to the limited information or awareness programs on the potential of greywater reuse as a clean supplement for fresh water [8]. A recent socio-economic study on greywater reuse shows that there is an overall acceptance for using high-quality treated greywater for toilet flushing, laundry, garden irrigation, but not for drinking [51]. In addition, the previous knowledge about greywater reuse, educational level, gender, and age are critical determinants of acceptability [51].

This study highlighted the potential reuse of greywater in shrubs/trees that are recognized as forestry trees, which would provide substantial services for the families as cultural services (recreation, landscape, etc.), provisioning services (fuelwood, fodders, etc), especially in drylands [52]. The forestry plantations grown with the greywater would work as a perfect substitute for the industrial forest plantation for fuel production to the local community, besides investing in the fuelwood trading [53]. This would support the national efforts in forestry protection and afforestation projects. The irrigation of forestry plantations with treated greywater is a realistic option for regions with shortages of adequate water resources. Adoption of this approach is clearly profitable due to the fact that the composition of greywater support biomass growth and further tree products. However, uncontrolled planting of *Prosopis* can lead to serious impacts on water availability and compete with other species for water. The daily average evapotranspiration of a *Prosopis* tree ranges from 3 mm to 4 mm, depending on canopy density. In Afar region, the estimated water use of 1.18 million ha of *P. julifora* L. was about 3.1–3.3 billion m^3 $year^{-1}$. This volume of water would be sufficient to irrigate about 330,000–460,000 ha of field crops [54]. Additionally, inefficient utilization and combustion of *Prosopis* and *Albizia* solid fuels generates a range of harmful emissions to the environment and could result in global heating. Therefore, the use of greywater for *Prosopis* and *Albizia* should be carried out with caution. Overall, legislation should be carried out to encourage farmers to adopt greywater reuse for irrigation crop species that accumulate low concentration of metals in their edible parts (e.g., safflower, sorghum, millet, carrots, radish, cucumber, tomatoes, eggplant, lettuce) and the reuse of greywater should be encouraged as an integral component in each country's national development strategic plan [55]. In addition, regular analysis of greywater, the use of advanced technologies to improve the filtration process, and the dilution of greywater with fresh water to lower the salt and metal toxicity and improve the irrigation water quality.

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