Effects of Irrigation with Treated-Filtred Waters on Some Agri-Food Products(The Region of Ouargla Agérie as a Case Study)

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Received: 05/2023 **Published:** 10/2023

Abstract:

The reuse of treated wastewater can reduce the water deficit in Saharan areas, particularly in Ouargla which has experienced a serious problem of water surplus, caused by a topographically flat land level, as well as the discharge of agricultural drainage water, which raises the groundwater level. The construction of a sewage treatment plant in Sidi Khouilid is part of governmental projects to capture and lower the level of the water table.The history of the microbiological and physico-chemical analyzes confirm that the quality of the waters of the SIDI KHOUILED treatment plants are currently very polluted with a very high rate of microbiological materials and extremely rich in salts, and the presence of various germs 'coliforms, streptococci and Clostridium' in very significant numbers.

Consequently it is very important to have additional treatment of purified water from STEPs to ensure a quality of purified water that complies with irrigation standards, and to ensure good discharge into the natural environment.In our experiment, we have treated the water with using a sand filter, which in turn gave good results.Microbiological analyzes of plants irrigated with purified-filtered water mixed with borehole water indicate the lack of faecal coliforms, streptococci and Clostridium in samples of Batavia lettuce and local chard.

Keywords: Wastewater, sand filter, purified, reuse, irrigation.

Tob Regul Sci. ™ 2023 ;9(2):455 - 480
DOI: doi.org/10.18001/TRS.9.2.30

Introduction:

The Ouargla basin, located north of the Algerian Sahara, is undergoing very rapid urbanization due to population growth. The increase in population and per capita drinking water consumption has led to an increase in the volume of wastewater discharges (Amal, Mustapha, & Lakhdar, 2015)

These discharges can contain many substances, in solid or dissolved form, as well as many pathogenic microorganisms, threatening the quality of the environment as a whole (Ounoki &Achour, 2014) . The reuse of treated wastewater for agricultural purposes is a widespread practice worldwide, especially in developing countries (Ouafae, Lahrach, & El Halouani, 2012)

Our study concerns the Sidi Khouiled wastewater treatment plant in Ouargla, Algeria, with a total flow of wastewater in the year 2030 equal to 1,094 m^3 /d.(Engineers, 2006) which is currently experiencing operational problems, resulting in a purified water quality that does not meet discharge standards (Benoit, Dauphin, DUCROCQ, NOUGAROL, & SALVA, 2011) .For this, we focused on improving the quality of purified water, and achieving an irrigation system that meets standards. We aim to control the quality of pure water by detecting the microbiological quality of plants used in irrigation.

The risks associated with the use of urban wastewater in agriculture and especially in Ouargla have already been assessed by several authors such as:

OUNOKI, S in 2014shows the suitability of the waters of the Said Otba STEP in Ouargla for irrigation without major negative impacts on the environment, provided that the crops grown are not intended to be eaten raw. (Ounoki & Achour, 2014)

AISSANI, NOUR ELHOUDA in 2021 said that microbiological analyzes confirm the presence of various germs such as total germs, total and faecal coliforms, faecal streptococci and sulfite-reducing Clostridium in appreciable numbers in the purified waters of the Ouargla STEP (AISSANI).

WHO standards have shown the suitability of these waters for irrigation without major negative impacts on the environment provided that the crops grown are not intended to be consumed raw (Ounoki & Achour, 2014).

BOUHANNA Amal in 2015 confirms that farmers have taken the initiative to use purified wastewater, without official authorization, for this the use of purified water in Saharan agriculture in Ouargla remains conditioned by the framework to promote water recovery refined throughout the agricultural sector of the Ouargla basin. (Amal et al., 2015)

NEGAIS Hamza in 2015says that the reuse of treated effluent from the Said-Otba WWTP in

Ouargla is possible and would therefore to some extent save drilling water. (Tahar, Hamid, & NEGAIS, 2015)

KHERROUBI Mostafa's work in 2019 focused on the possibility of exploiting plants irrigated by purified water from the Sidi Khouiled d'Ouargla wastewater treatment plant. And to determine the bacteriological characteristics of purified wastewater from the Sidi Khouiled wastewater treatment plant after filtration, and to compare these characteristics with Algerian and international standards for reuse in agriculture. (M. KHERROUBI & KACI, 2019)

KHERROUBI Fatma's work in 2016 consists of studying the purification performance of the urban water treatment plant by aerated lagooning in the city of Sidi Khouiled, and evaluating the physicochemical quality of raw and purified wastewater from the Sidi Khouiled WWTP. (F. KHERROUBI & DEBBOUNE, 2016)

The research of AZIZI, Khaoula in 2022 contributes on the one hand to the study of the reuse of treated water for irrigation and, on the other hand, to deepen research in the field of surface irrigation in arid regions (AZIZI & DEROUICHE)

BELAID, Ouahiba in 2017 showed the use of activated carbon prepared from local date kernels in the treatment of urban wastewater in Ouargla. (Influence of the variety of dates.(Belaid, 2017)

The majority of these studies have only focused on the identification and occasional quantification of polluting microorganisms in irrigation water in the soil and on crops (Amoah, Drechsel, Abaidoo, & Ntow, 2006).

Instead, our study is based on looking at the extent to which certain plants are not exposed to pathogenic microorganisms such as coliforms, Clostridium, streptococci and that after having irrigated it with water from the sewage treatment plant of Sidi Khouiled, by a hydroponic system.

Materials And Methods

The Ouargla basin is located in the extension of the natural outlet of the great watershed of the northern Sahara. It is limited to the north by the Saharan Atlas, to the south by the Tadmait plateau, to the east and west respectively by the eastern and western ergs. The study area is an endorheic zone fed to the north by floods from the Wadi N'sa, south by Wadi Mya and to the west by infiltration of water from Wadis Metlili and M'zab(Engineers, 2006).The irrigated soils in this region are most often very salty(Hamdi-Aissa, Vallès, Aventurier, & Ribolzi, 2004) . This salinity is stimulated by the rise in the water table (Amal et al., 2015) . However, our study focuses

on the Sidi Khouild region of Ouargla. Negligible industrial water discharges (Habben, 1974) the solution adopted for the purification of the effluents generated by the municipality of Sidi Khouiled consists in treating all the waste water from an aerated lagoon-type treatment plant.

This study is characterized by carrying out microbiological and physico-chemical analyzes of purified water and sand-filtered purified water, in order to obtain a water quality according to the irrigation standard.

We made a choice of two plants widely consumed in the city of Ouargla, the 'batavia brava' variety of lettuce, and the local chard variety, with the use of an above-ground irrigation system of the NFT as a recent technique,which is characterized by benefits like: avoidance of the use of weed killers and pesticides (Anin et al., 2016) .

In our experience, the determination of the physical characteristics of irrigation water depends on the determination of the physical characteristics of certain soil samples that characterize the presence of selected crops in our region. For this purpose, three regions of the city have been selected, namely "zone 1, zone 2, zone 3" see the figure below.

The physical soil characteristics used in our work are: electrical conductivity EC, total dissolved solids TDS, dissolved oxygen OD , and hydrogen potential PH, all of which are related to the percentage of soil organic matter (Koull & Halilat, 2016).

Figure N°1: the areas where soil samples were taken or the establishment of lettuce and local chard in the Ouargla region

The following table gives the physical characteristics of the selected soil samples:

Table N°: 1 Characteristics of soil samples

	SOIL1		SOIL2		SOIL3		SOIL4 (mix)		Irrigation water
	Echt1	**Echt2**	Echt1	**Echt2**	Echt1	**Echt2**	Echt1	**Echt2**	
EC	4.350	**3.299**	3.551	**3.033**	3.726	**2.771**	3.589	**2.891**	EC=

PH	8.00	7.3	5.57	7.41	6.81	6.81	7.24	7.2	/
O_2 ppm	1.44	0.77	-	0.7	-	0.4	-	0.56	/
TDS	2167	1650	1779	1530	1873	1407	1760	1448	/
Sal (psu)		1.71		1.61		1.47		1.5	/

According to the table above, the allowable EC conductivity of our Soil between 2.771 and 4.35 mS/cm, PH between 5.57 and 8, TDS between 1407 and 2167mg/l, which we consider to be the same properties that we use in irrigation water.Knowing that the electrical conductivity EC of water from the irrigation well used in these areas reaches 7.95 mS/cm.

And for the preparation of seedlings, we plant the grains of the ' lettuce batavia brava' and the local variety 'chard' in plastic cups filled with a soil rich in organic matter with 60% black peat and 40% blond peat which are perforated on the sides and at the bottom so as to allow access of water to the roots, and we startthe irrigation by a water mixture between 40% water filtered by sand from the N'Goussa area and 60% drinking water from the Gharbouz borehole whichelectrical conductivity EC between 2 and 3 mS/cm from 02/14/2022. in a way to have a water quality corresponding to the characteristics of irrigation water, see the figure below.

Figure N°2: Situation of grains of 'batavia brava lettuce ' and 'chard' on 02/14/2022

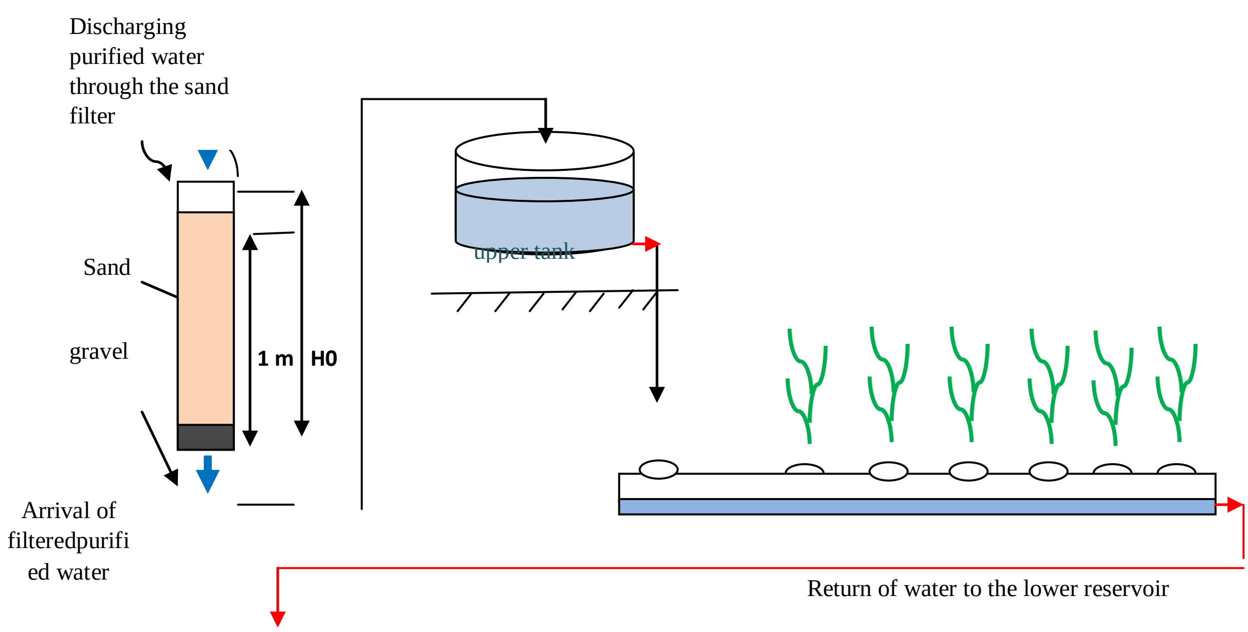
After preparing the seedlings, we proceed to the preparation of the filtration system, this sand filtration process system is made using vertical PVC columns 110 mm in diameter and 120 cm in height filled with three types of sand:sand from the N'Goussa area, sand from the Ain Beidha area and sand from the Hassi Ben-Abdallah area.In order to determine the best filter that would allow optimal purification of the purified water, the columns are placed vertically in a cylindrical shape. A layer of medium gravel of 10 cm thick was placed at the bottom of each column to ensure good water drainage, (Kaddouri, 2019)the columns were rinsed several times with tap water in such a way as to ensure stability of the electrical conductivity of the water entering and leaving the filter. See figure N°4

The principle of filter operation is as follows:

- The first operation is to fill these filters with AEP borehole water and let them sit for 24 hours, these filters are drained after this time to ensure that the sand salts have dissolved, this process is repeated for 6-7 dayswhere to obtain the stability of the electrical conductivity of the water at the inlet and at the outlet of the filter.
- We determine the pollutant load of the purified water before and after passing through the filters in order to determine the purification efficiency.
- The same effluent is poured over the three filters for a calculated average infiltration rate Q_m 0.030 = l/min with a constant head H_0 = 1.2 m see the filter diagram in figure N°3.
- We choose the best filter that gives water quality within the standards.
- Finally, each time we fill a quantity of 40 l of purified-filtered water, we pour this quantity into our irrigation system see figure N°3

Analysis parameters in our system are Biological Oxygen Demand (BOD5), Chemical Oxygen Demand (COD), Suspended Solids (SS), pH, Electrical Conductivity for physico-chemical analyzes as necessary measurements to the quantification of organic pollutants (Rokbane &Debabeche, 2022) , and faecal coliforms , streptococci, Clostridium on the other hand, as measurements necessary for the quantification of microbiological analyses.

We begin our experiment by the realization of three systems of irrigation above ground with a control system of traditional irrigation on the ground. The above-ground irrigation system or what we call 'NFT' type hydroponics works automatically using a pump-float which raises the purified-filtered water from a lower tank to another upper tank which then feed the plants install in horizontal PVC channels and with a permanent flow and drop by drop and in a closed circuit, see figure N°3.



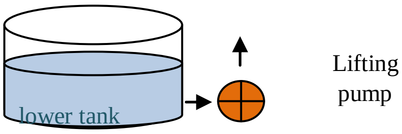


Figure N°3: Plant feeding diagram in the aboveground irrigation system

In the first system, only purified-filtered water is irrigated, however in the second and third systems, water is irrigated with a mixture of between 40% purified-filtered water and 60% borehole water from AEP Gharbouzwhich electrical conductivity EC between 2 to 3 mS/cm, the principle of operation of these filters is that 40 l of purified-filtered water have been introduced into the irrigation system as a maximum capacity, with the change of 20L each weekend with new purified water -filter, we repeat this process every week, taking weekly measurements of the physical characteristics of these waters such as EC, TDS, PH, dissolved O see Table No. 6. On the other hand, we stop the change of water in the third system from the third week.

This type of mixed or diluted water irrigation has been used in low-income countries, particularly in Asia, Latin America and sub-Saharan Africa, where this wastewater is discharged into water bodies and therefore used under diluted form, despite the health risks to farmers and consumers. (Keraita, Jiménez, & Drechsel, 2008)

The essential characteristics of soilless culture reside in the fact that the roots of the plant are immersed in the nutrient solution which can be continuously circulated.
Among the disadvantages of the system is the difficulty of aeration, and it requires frequent renewal of the solution (Amal et al., 2015) See the following figures:

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Float Pump Sand Above Ground Irrigation

In addition, the installation of a control system of subsoil irrigation is just to compare these crops with other irrigated crops above ground, in terms of crop development and in terms of microbiological analysis.

Results And Discussion

We started our work with microbiological analyzes of the purified-filtered waters using a single sand filter at first, then we did physical-chemical and microbiological analyzes of the purified-filtered waters of the three other filters, to obtain the best as we will show below.

A series of microbiological analyzes of purified water from the SIDI KHOUILED treatment plant are initiated at the Algerian Center for Quality Control and Packaging -CACQE to assess the count of bacteria indicative of faecal contamination such as coliforms, Streptococci , and Clostridium.

These analyzes were carried out over two periods, with samples of purified water and others mixed with drinking water supply drilling water AEP Gharbouz as a control sample, and others with purified water filtered by sand from the dunes, see these analyzed in the two tables N°2, N°3.

Table N°: 2 Microbiological Analyzes Of Treated Water From STEP SIDI KHOUILED

Types of analysis	Purified water (water from STEP SIDI KHOUILED)		Mixed water (40% borehole and 60% purified)		Mixed water (60% borehole and 40% purified)		Borehole water (as control sample)	
	sample 1	sample 2	sample 1	sample 2	sample 1	sample 2	sample 1	sample 2
Faecal coliforms	$130X10^{+3}$	$138X10^{+3}$	$120X10^{+3}$	$100X10^{+3}$	$64X10^{+3}$	$62X10^{+3}$	negative	negative
Clostridium	Presence	Presence	Presence	Presence	Presence	Presence	negative	negative

Date of analysis: 01/16/2022

Table N°: 3 Microbiological analyzes of treated water from STEP SIDI KHOUILED

Types of analysis	Purified water (water from STEP SIDI KHOUILED)	Mixed water (80% borehole and 20% purified)	Mixed water (90% borehole and 10% purified)	Water purified and filtered by N'Goussa dune sand)

	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
Faecal coliforms	**Indeterminate > 300X10 $^{+3}$**	Indeterminate > 300X10 $^{+3}$	91X10 $^{+3}$	250X10 $^{+3}$	187X10 $^{+3}$	287X10 $^{+3}$	1X10 $^{+3}$	7X10 $^{+3}$
Clostridium	Presence	Presence	6*10 ^{3}	Presence	2*10 ^{3}	Presence	Presence	Presence

Date of analysis: 01/24/2022

- The results show that the number of faecal coliforms in the case of the mixed water samples taken on 01/16/2022 is less than the samples taken on 01/24/2022, despite the use of high percentages of 80% and 90% well water, so we conclude that the coliform concentration changes from sample to sample.
- The presence of Clostridium in the samples, but not counted, due to the presence of a black color in all the analysis tubes.

These results show that purified water - filtered by sand is better because of a very reduced number of coliforms.

To improve the water quality of our treatment plant, we choose three other types of sand filter to detect their physico-chemical and microbiological performance, such as sand filter N°1, N°2, N°3.

The microbiological analyzes confirm the presence of streptococci and the absence of Clostridium in all the samples according to Table N°2. However, the physico-chemical analyzes are done with the aim of finding the best sand filter performance, which gives good performance of the parameters of BOD5, DCO, SS,…ext see the following two tables:

Table N°: 4 Results of microbiological analyzes of purified-filtered water

Types of analysis	Purified water (water from STEP SIDI KHOUILED)		Water purified-filtered by Ain Beida sand(#1)		Water purified-filtered by N'Goussa sand (N°2)		Purified-filtered water by sand Hassi ben Abdellah (N°3)	
	Sample 1	**Sample 2**	**Sample 1**	**Sample 2**	**Sample 1**	**Sample 2**	**Sample 1**	**Sample 2**

Streptococcus	**Presence**	**Presence**	**Presence**	**Presence**	**Presence**	**Presence**	**Presence**	**Presence**
Clostridium	Absence	Absence	Absence	Absence	Absence	Absence	Absence	Absence

These results show the presence of streptococcus by values higher than 2380 unit/100 ml according to the analyzes carried out at the level of the Direction of Health Protection Ouargla-Algeria.

On the other hand, the physico-chemical analyzes of the purified-filtered water of 03/30/2022 according to ANRH OUARGLA laboratory, are in tables N°5, following:

Table N°: 5 Results of physico-chemical analyzes of purified-filtered water

Types of analysis	purified water by STEP SIDI KHOUILED	Water filtered by hassi ben abdellah sand (N°3)	Yield %	Water filtered by sand Ain beida (N°1)	Yield %	Water filtered by N'Goussa sand (No. 2)	Yield %	Irritation reuse standards
COD	**337**	**167.4**	50.33	**177.2**	47.42	**87**	74.18	90mg/l
BOD_5	**215**	**45**	79.07	**57**	73.49	**24**	88.84	30mg/l
SS	**304**	**39**	87.17	**42**	86.18	**19**	93.75	30mg/l
CE	**5.70**	**5.67**	-	**6.07**	-	**6.4**	-	Greater than 3 mS/cm
pH	**8.02**	**7.84**	-	**7.92**	-	**7.96**	-	6.5-8.5
SO_4^{--}	**987.5**	**1062.5**	-7.59	**2050**	-107.59	**2750**	-178.48	Greater than 500mg/

Nitrates	**0**	**0**	-	**0**	-	**0**	-	50mg/l
Nitrites	**0**	**0**	-	**0**	-	**0**	-	0.1mg/l
Results of analysis of some plant nutrients Na^+, K^+, Mg^{++}, Ca^{++}								
Na^+	**610**	**700**	-14.75	**600**	1.64	**590**	3.28	Non-toxic metal for a value up to 10 g/l
K^+	**46**	**90**	-95.65	**66.5**	-44.57	**20.5**	55.43	12mg/l
Mg^{++}	**135.7**	**204.8**	-50.92	**256**	-88.65	**220**	-62.12	150mg/l
Ca^{++}	**180**	**195**	-8.33	**250**	-38,89	**237,5**	-31,94	200 mg/l

The table shows that the sand filter of the N'Goussa N°2 zonegives a good purifying yield and complies with irrigation standards, except for sulphate concentrations higher than irrigation standards because irrigated plants in the region are very tolerant to sulphates. Their concentration is usually measured to check for deficiencies rather than to check for potential excesses. Sulfur deficiencies can be apprehended if the irrigation water contains less than 48 ppm of sulphates(Couture & Montérégie-Est, 2004) . With the richness of these purified-filtered waters in $Na^{+,}$ $K^{+,}$ Mg^{++}, Ca^{++} nutrient elements, which exceed the irrigation standard, which shows the value electrical conductivity EC go to 6.4 mS / cm, this level is due to the salinity of irrigation water and the high level of salty groundwater is a source of salinization for irrigated soils in the basin of Ouargla (BOUHOUN et al., 2012) on the one hand and the Mid-Pliocene and Senonian catchment aquifers on the other hand which are characterized by higher than normal magnesium and potassium values. (LACHACHE & BOUDJENAH-HAROUN)

Concerning the follow-up of our above-ground irrigation system, we take weekly readings of the electrical conductivity EC, the rate of dissolved solutions TDS, the PH as well as the dissolved oxygen and this for the irrigation water in the system, and for the irrigation water added to the system each week, with the reading of the concentrations of some nutrients such as Ca ++, K , Na+, Cl.

As in the first system, only purified filtered water is used.On the other hand in the 2nd and 3rd system, a fixed volume of 60% drilling water is used with 40% purified-filtered water, in a way to keep the physical characteristics of irrigation water ideal for the development of our crops, such as the EC conductivity of our implantation soil between 2.771 and 4.35 mS/cm, PH between 5.57 and 8 and TDS between 1407-2167mg /L.

The installation of the 3rd system is just to compare the evolution of plants with the previous system, such as the use of mixed water between purified-filtered water and drilling waterin a way that stops the doses of changes in waters mixture from the third week.

The characteristics of irrigation water for the three systems are in the following tables:

Table N°: 6 Characteristics of the purified-filtered water of the 1st system over time

1st above ground system with the use of purified-filtered water	No. Week	Water Purified - filtered in the system					Volume of water Purified Filtered to be reduced	Water Purified Filtered to added				
		Total system volume	EC water Purified Filtered (mS/cm)	TDS water Purified filtered (mg/l)	pH	Dissolved O (ppm)		Volume added	EC water Purified Filtered mS/cm	TDS water Purified filtered (mg/l)	pH	O Dissolved (ppm)
	1	40L	6.5	3252	8.04		0L	0L	-	-	-	-
	2	40L	6.56	3284	8.27		20L	20L	5.54	2774	8.28	17.6
	3	40L	4,755	2624	8.31		20L	20L	4.78	2393	8.17	8.9

	4	40L	5,913	2963	8.00	0.46	20L	20L	4.505	2248	7.91	1.65
	5	40L	6,257	3131	5.80	16.48	20L	20L	4.056	2026	7.74	10
	6	40L	6.5	3250	7.84	12.4	20L	20L	4.09	2045	6.93	
	7	40L	7.73	3860	7.78	1.5	20L	20L	5.09	2545	7.56	-

Table N°: 7 Characteristics of mixed waters of the 2nd system over time.

2nd above ground system with the use of purified-filtered mixed	Mixed waters (purified-filtered + borehole water) in the system					Volume of purified water to be reduced	Mixing waters (purified-filtered + borehole water) added					
	No. Week	Total system volume	EC water Mixture (ms/cm)	TDS water Mixture (mg/l)	pH		Volume a added	% minimum borehole water volume requested	% volume of borehole water installed	EC water Mixture (ms/cm	TDS water Mixture (mg/l)	pH
	1	40L	4,287	2142	8.14	0L	0L	-	-	-	-	-

	2	40L	4,284	2143	7.94	20L	20L	40	60	3,623	1802	8.30
	3	40L	3.189	1597	7.21	20L	20L	22	60	3.4	1701	8.34
	4	40L	3,591	1802	8,49	20L	20L	20	60	3,331	1604	9.05
	5	40L	3.87	1936	8.76	20L	20L	0	60	2.81	1405	-
	6	40L	3.92	1960	7.91	20L	20L		60	3,416	1708	-
	7	40L	4.77	2390	7.89	20L	20L	30	60	3.512	1756	-

Table N°: 8 Characteristics of mixed waters of the 3rd system over time

3rd above ground system with the use of	Mixed waters (purified-filtered + borehole water) in the system					Volume of purified water to be reduced	Mixing waters (purified-filtered + borehole water) added					
	No. Week	Total system volume	EC water Mixture (mS/cm)	TDS water Mixture (mg/l)	pH		Volume a added	% min volume of drilling water requested	% volume of borehole water installed	EC water Mixture (mS/cm)	TDS water Mixture (mg/l)	pH

	1	40L	4,287	2142	8.14	0L	0L	-	-	-	-	-
	2	40L	4,284	2143	7.94	20L	20L	40	60	3,623	1802	8.30
	3	40L	3.189	1597	7.21	20L	20L	22	60	3.4	1701	8.34
	4	40L	3,637	1815	7.99	-	-	-	-	-	-	-
	5	40L	4.05	2228	8.61	-	-	-	-	-	-	-

- The following graphs show the variation of the electrical conductivity EC and the TDS and also the concentrations of some nutrients as a function of time.

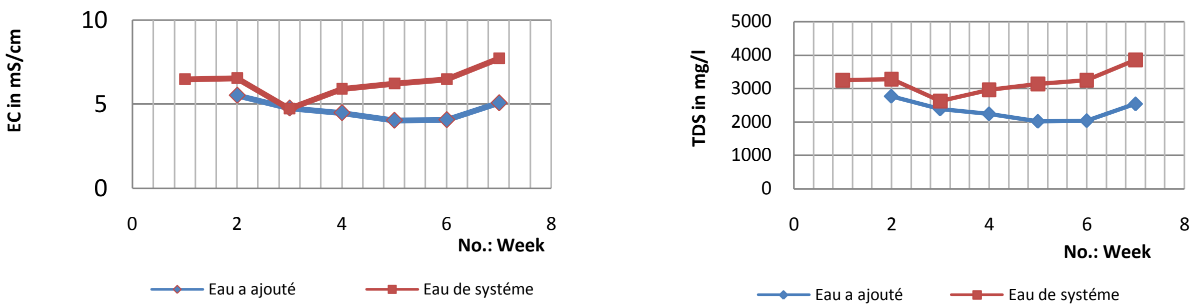


Figure N°4: Curve of variation of electrical conductivity EC and total dissolved solids TDS over time for purified-filtered water

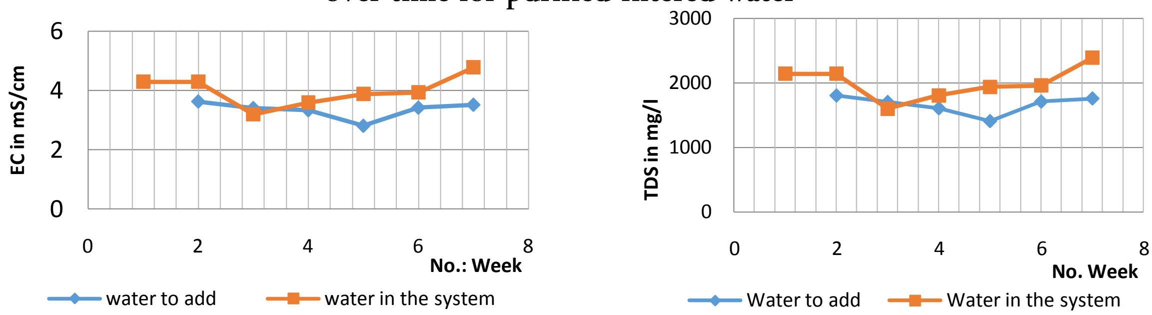


Figure N°5: Curve of variation of electrical conductivity EC and total dissolved solids TDS over time for mixed waters between 40% purified-filtered water and 60% borehole water, caseof 2nd system

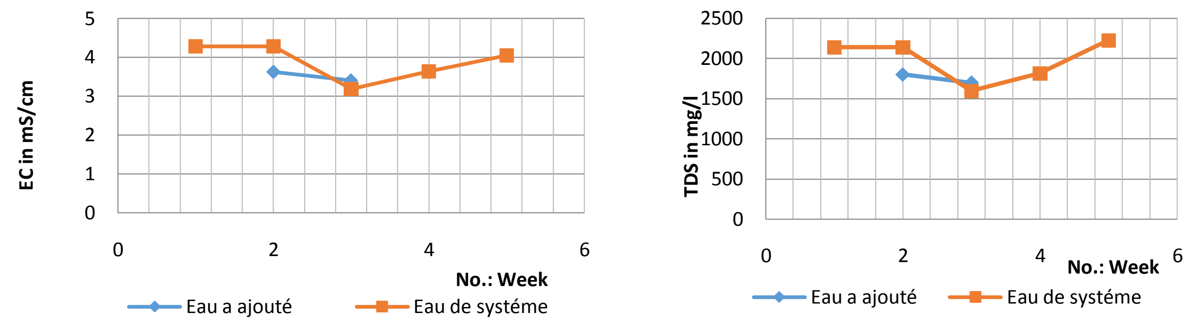


Figure N°6: Curve of variation of electrical conductivity EC and total dissolved solids TDS over time for mixed waters between 40% purified-filtered waters and 60% borehole waters, caseof 3 rd system

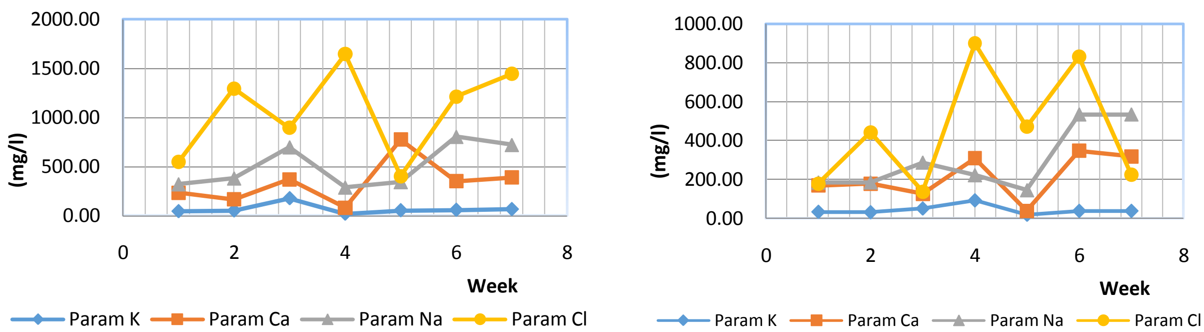


Figure N°7: Concentration variation curveFigure N°7: Curve of variation of the concentrations ofnutrients Na $^{+}$, Ca $^{++}$, K, Cl Case ofNa $^{+}$, Ca $^{++}$, K, Cl Case of waterspurified-filtered water purified-filtered water and borehole water

The curves above show:

A continuous increase in electrical conductivity EC and TDS in the three systems as a function of time despite changes in the doses of purified water filtered over the weeks, and this is due to the evaporation of purified water and the aspiration of water by the plants during the weeks serves to decrease the amount of water in the system and therefore the increase in the concentration of dissolved salts TDS and therefore increase in EC in the water. Also this increase in the level of dissolved salts results from the mineralization of a large part of the organic matter by bacteria.(kaddouri, 2019) .

Thevariation of the electrical conductivity in the three systems is proportional with the TDS

(Total dissolved solids), such that the electrical conductivity indicates the concentration of dissolved salts in the water (Wassila et al., 2012) . These two parameters are correlated, and generally expressed by an equation TDS (mg/l)= K x EC (μS/cm) and K= 0.55- 0.75 in the case of irrigation water (Rusydi, 2018) .

Thelatest curves N7 and N8 indicating that the filtered purified water is rich in nutrients K, Ca, Na, Cl to different degrees, such as the presence of chlorine Cl^- as the highest concentration and potassium K^+ the lowest concentration.

The plant evolution of lettuce and local chard of the three systems are presented in the tables below, considering that, the results mentioned in these tables refer to the maximum values of 11 lettuce samples for each system, and during each week.

Table N°9: shapes and characteristics of lettuce in the 1st system

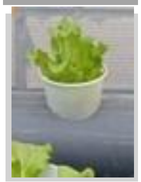
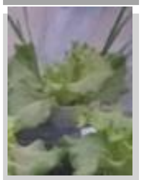
Week	1	2	3	4	5	6	7
Shapes of lettuce leaves over time							
Max sheet lengths (cm)	10	10	12	15	17	18	20
Lettuce root forms over time	-	-			-	-	-
Root Lengths (cm)	6	10	17	17	18	18	19

Table N° 10: shapes and characteristics of lettuce in the 2nd system

Week	1	2	3	4	5	6	7
Shapes of lettuce leaves over time							

Max sheet lengths (cm)	10	10	12	12	13	14	15
Lettuce root forms over time	-				-	-	-
Max Root Lengths (cm)	4	10	30	35	39	42	45

Table N°11: forms and characteristics of plants in the 3rd system

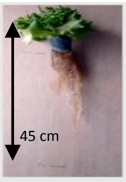
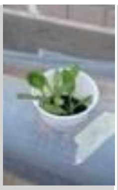
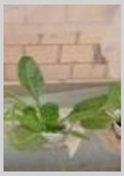
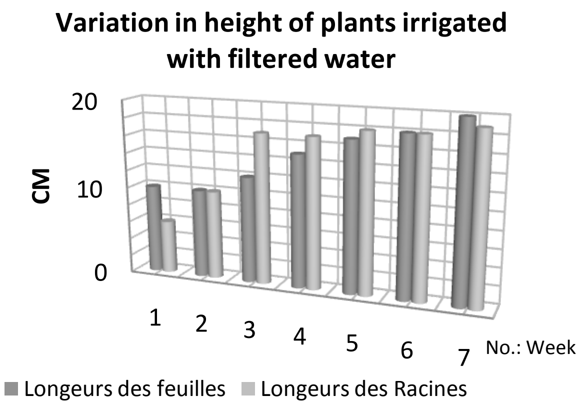
Week	1	2	3	4	5	Comments
leaf shapes of lettuce over time						
Max sheet lengths (cm)	10	10	8	8	8	) with long roots up to 45cm, after the 5th week
Week	1	2	3	4	5	
Lettuce root forms over time	-	-	-	-		
Max Root Lengths (cm)	4	7	7	35	45	

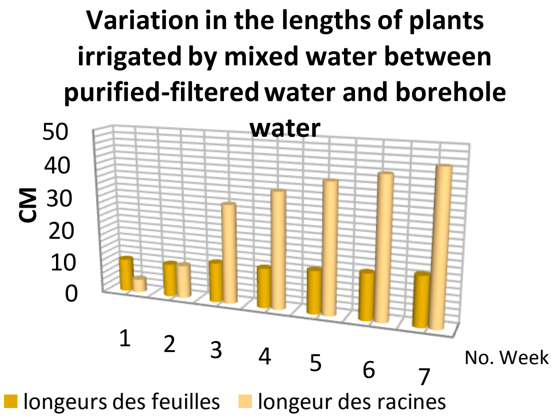
Table N°12: forms and characteristics of local chard in the 1st system

Week	1	2	3	4	5	6	7	8
Shapes of local chard leaves over time			-				-	
Max sheet lengths (cm)	5	7	10	10	15	18	22	28

The 3 rd system was stopped due to the shape of the plants, which shows the decline of the leaves with an astonishing increase in the length of the roots, which obliges to maintain the system of changing irrigation water every week.

The following histograms show the variation in leaf heights and root lengths of lettuce





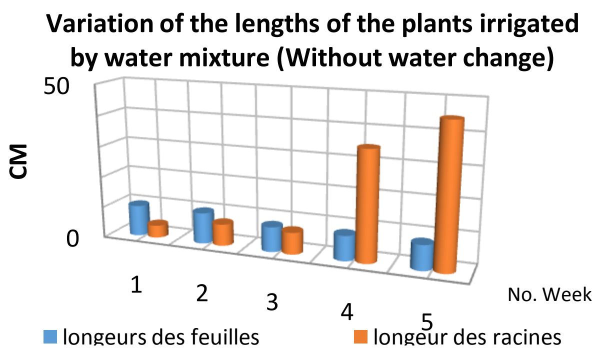


Figure N° 8 histograms of variation in leaf height and root length in lettuce

The histograms below show that the lettuce develops well in the case of irrigation with purified-filtered water, so that in the seventh week we find the appearance of long and wide leaves of more than 20 cm. On the other hand, in the case of irrigation with water mixed with AEP drilling water, leaf width does not exceed 15 cm, with roots up to 45 cm long due to nutrient deficiency in irrigation waters: the previous curves show this case. But the third system shows that the leaves of the plants take a reduced (shriveled leaves) with roots more than 45 cm long after the fifth week due to the absence of change in the doses of water from the third week.

By comparing these three systems with the control system, it was found that this system gives similar developmental results with the first two systems, such as lettuce leaves up to 15 cm wide, after the seventh week, Swiss chard local has leaves between 8 and 25 cm long after the seventh week, see figures below.

BATAVIA lettuce	The local chard

Figure No. 09 Satiation of subsoil irrigated plants after the seventh week

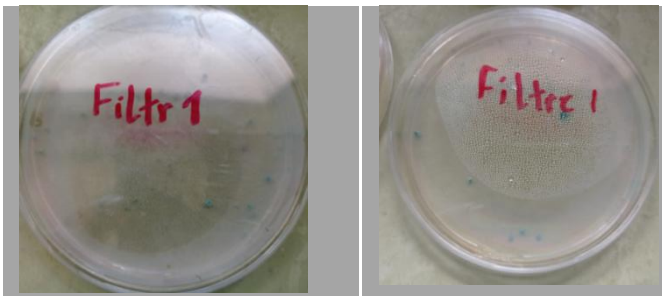
The microbiological analyzes of the plants are carried out at the level of the Algerian Center for Quality Control and Packaging (CACQE) on 04/17/2022, by determining the microbiological mass; coliforms, streptococci, Clostridium for different samples of lettuce, and local chard . and as follows:

- For Sample Preparation : We weigh 10 g of each sample of lettuce and local chard, put these samples in sterilized bottles, and fill these bottles with TSE water up to 100 ml, such as TSE= (1.5 g Tryptone wateur + 8g NaCl) and leave these samples for a moment of 15 minutes. It is considered that the microbiological quality of food could be related to the quality of available water used for food preparation [7]. See the following figure:

Figure 10 : Samples of lettuce and local chard with TSE water

To detect faecal coliforms, 1ml of each sample is put with [12 to 15 ml] of TBX medium (chromogenic Agar), and these dishes are left in an oven at 44° and for 24 hours, and for detection of Clostridium we put 1ml of each sample with [12-15 ml] of the IRON SULFITE AGAR medium and we leave these tubes in an oven at 37° and for 24 hours, and at the end to detect streptococci, we put 1ml of each sample with 10 ml of ROTH medium, and these tubes are left in an oven at 46° and for 24 h.

- The results of microbiological analyzes of lettuce and local chard in terms of detection of faecal coliforms, streptococci and Clostridium show the presence of 180 to 200 CFU/g with the presence of streptococci and even the presence of Clostridium from 10 to 20 Unit/g in the two samples of lettuce, however, we find the lack of these microbiological parameters in all the other samples of lettuce with rinsing with water and a few drops of bleach, see figures and table below



Sample Filter 1 :

(irrigated with purified-filtered water and without rinsing with water and a few drops of bleach)

Result :

180 and 200 CFU/g

Figure 11 : Presence of faecal coliforms in the samples

Presence of germs

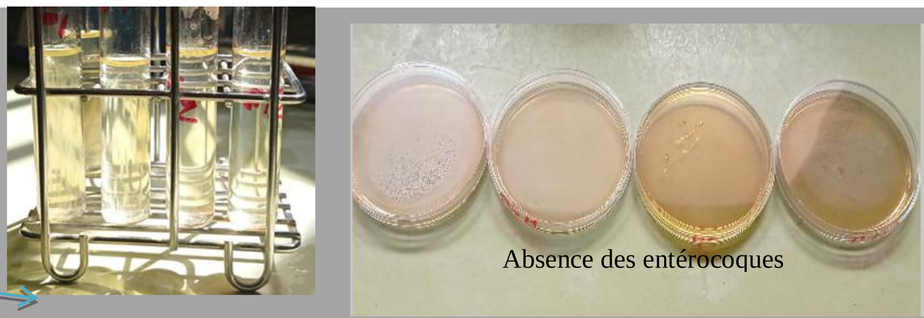


Figure N°12 : Presence of streptococciin the lettuce samples and without rinsing with water and some

Drops of bleach with absence of enterococci for same samples

This figure shows that to confirm the presence of streptococci by passing to the detection of enterococci, while we put a quantity of positive sample by a rod in petri dishes which are prepared by an agar (BILE ESCULIN AZIDE AGAR) and left in an oven for 24 hours,which shows the absence of enterococci and therefore the absence of streptococci in the samples.

Other results are presented in the table below, where these results show the microbiological analyzes of two leaf samples from 11 plants of Batavia lettuce and local Swiss chard.

Table N°13: Results of microbiological analyzes of lettuce and local chard

Plant type	No.: Samples	Sample Description	Faecal coliforms	Faecal streptococci	Clostridium
The lettuce	1	Sample of lettuce irrigated with filtered water and without rinsing with water and a few drops of bleach	18x10 – 20x10 CFU/g	Presence	01x10 - 02x10 Unit/g
	2	Sample of lettuce irrigated with filtered water and rinsed with water and a few drops of bleach. (0.0103025g/l).	0 CFU/g	Absence	Absence
	3	Sample of lettuce irrigated with mixed water and without rinsing with water and a few drops of bleach.	01x10 – 01x10 CFU/g	Presence	Absence
	4	Sample of lettuce irrigated with mixed water and rinsed with water and a few drops of bleach.	0 CFU/g	Absence	Absence
	5	Lettuce implanted in a forest field irrigated by water from irrigation borehole	Absence	Absence	Absence
	6	Lettuce irrigated by **filtered purified water** with bleach rinses. (2nd sample)	Absence	Absence	Absence
The local chard	1	**filtered** purified water with cooking for 10 minutes.	Absence	Absence	Absence
	2	**mixed** water (purified filtered + drilling water) with water rinses + drops of bleach.	Absence	Absence	Absence

	3	**mixed** water (purified filtered + drilling water) with cooking for 10 minutes.	Absence	Absence	Absence
	4	Swiss chard planted in a forest field irrigated by irrigation borehole water	Absence	Absence	Absence
	5	**filtered** purified water with bleach + water rinses	Absence	Absence	Absence
	6	Chard irrigated with **mixed water** (purified filtered + borehole water) without water rinsing (directly from the forest)	Absence	Absence	Absence
	7	The water-irrigated chard **mixes** (filtered purified +bore water) and steams for four minutes.	Absence	Presence of germs	Absence

4-General conclusion:

In our experiment, the physical, chemical and microbiological analyzes of purified water from the Sidi **Khouiled station**in Ouargla show a very heavy water quality such as a maximum value for BOD_5 up to 215 mg/l, COD up to at 337mg/l, the SS for a value of 304 mg/l, and 987.5 mg/l for sulfur dioxide -, with more than 300 $x10^3$ CFU/g, and more than $6x10^3$ unit/g of Clostridium and more than 2380 Units/100ml of streptococci.

Because of these results, we used water diluted with AEP Gharbouz drinking water supply borehole water. Analyzes of this water show a maximum value of 287 x 10^3 CFU/g, and 6 x 10^3 Unit/g of Clostridium, which still indicates a quality that does not comply with irrigation standards.

- However, the results of analyzes of water filtered by N'Goussa sand gave good results, for example from 1 to 7 x 10^3 CFUwith an elimination efficiency of more than 97.56%, considering that the value is 287 x 10^3 CFU/g as maximum value, with BOD_5 value 24 mg/l with 88.84% yield, and 19 mg/l SS with 93.75% yield , and a value of 87 mg/l of COD for a yield of 74.18%. , for this we have focused on the use of this type of filter .

Chemical analyzes of nutrients indicate the richness of purified water and soil by the elements of Na +, K +, Mg ++, Ca ++ in varying degrees with values above standards, which indicates salinity of these waters and therefore high values of the electrical conductivity of the purified- filtered waters .

The monitoring of the physical parameters of irrigation water shows a continuous increase in electrical conductivity EC and TDS in the three above-ground irrigation systems despite the different doses of purified - filtered water over the weeks, and this because of the evaporation of the purified water on the one hand and the aspiration of water by the plants on the other hand, which reduces the quantity of water in the system, and therefore the increase in electrical conductivity EC up to 7.73 mS/cm in the case of purified-filtered water and up to 4.77 mS/cm in the case of water mixed with borehole water.

- Our experience shows that plants irrigated with purified-filtered water give good results such as lettuce leaves which are more than 20 cm wide with 17 cm of roots at the seventh week. However plants irrigated with water mixed lettuce leaves reach 15 cm in width and over 45 cm in root length by the seventh week.On the other hand, we stopped the third above-ground irrigation system because of the leaves of the dry yellow plants with a maximum length of 8 cm, which shows their decline, with an astonishing increase in the length of the roots, because they reach a length of 45 cm. This indicates a deficiency in the percentages of nutrients. Sochanging the irrigation water every week is very necessary, at least once.

In terms of the microbiological qualities of the plants, we observe:

- Lack of faecal coliforms, faecal streptococcus, clostridium in the majority of samples of BRAVA batavia lettuce and local chard knowing that these analyzes are prepared using: rinsing samples with water and a 0.0103025 g/l dose of bleach, samples in their natural state without rinsing, samples cooked for 10 minutes, and others steamed for four minutes .

Finally, the local chard plant in hydroponic system is said to give good results in terms of plant development and microbiological quality, which indicates that this plant is not affected by this quality of water. On the other hand, Batavia lettuce gives good results, but it must be washed well before being consumed.

Acknowledgements

I would like to warmly thank all the teachers and professors of the Faculty of Civil and Hydraulic Engineering, University of Kasdi Merbah, Ouargla-Algeria who contributed to the development of our work, I also thank the Laboratory of Water Engineering and of the Environment in the Saharan environment for their help.

Grant Support Details

This research has not received any direct financial support except the contribution of the Laboratory of Water and Environmental Engineering in the Saharan environment, through the material and equipment of the lab.

Conflict of interest

There is no conflict of interest regarding the publication of this paper.

Life Science Reports

Of course, no threats on life sciences were practiced in this research and paper and no scientific assaults were carried out during this research.

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