Annals of Agric. Sci., Moshtohor **ISSN 1110-0419**
Vol. 55(4) (2017), 931 – 940 **http://aasj.bu.edu.eg/index.php**

Schinus molle L. Seedling responses to cheese whey irrigation

Tarek M. Aboudahab, Amira F.Y. El-Kady and Sahar T.A. Ewis
Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, Egypt.
Corresponding author: saharthabet78@yahoo.com

Abstract

The dairy industry is one of the main sources of industrial effluent; this industry is based on the processing and manufacturing of raw milk into deferent products such as cheese. Cheese whey is simultaneously an effluent with nutritional value and a strong organic content. The present study was conducted to determine the effect of irrigation using various types of cheese whey (CW) and potable water (PW) on *Schinus molle* L. seedlings to evaluate its growth and pigment contents. The study was carried out at the experimental nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during seasons of 2014/2015 and 2015/2016. The experimental design was a randomized complete block design using nine treatments as follow: PW (control) (0:1), Kareish cheese whey (KCW) (1:0) and (1:1), Mozzarella cheese non salty whey (MCNSW) (1:0) and (1:1), Mozzarella cheese salty whey (MCSW) (1:6) and (1:8), and Domiati cheese whey (DCW) (1:12) and (1:16). Growth characters (stem diameter (mm), main root length (cm), shoots and roots fresh weights (g), and shoots dry weight (g)) were measured, in addition to pigment contents (chlorophyll *a*, *b*, and total carotenoids (mg/g)) determination. The results indicated that irrigating plants with DCW (1:12) and (1:16) and MCSW (1:6) and (1:8) recorded the highest significant growth and pigment contents than those irrigated with MCNSW and KCW as compared to the control in both seasons. The data showed that usage of different CW types proved to be an economic way to dissolve water scarcely problems.

Key words: Cheese whey reuse, Water scarcely, Dairy industry, Industrial effluent, Brazilian pepper tree.

Introduction

The dairy industry is one of the main sources of industrial effluent generation. This industry is based on the processing and manufacturing of raw milk into different products. The characteristics of dairy effluents may vary significantly depending on the final products, system type and operation methods used in the manufacturing plant. These effluents are mainly composed by different dilutions of milk or transformed products (**Carvalho *et al.*, 2013**). From an environmental point of view, among the dairy effluent key parameters, a considerable high organic load should be highlighted. The organic matter content is mainly due to the presence of milk carbohydrates and proteins such as lactose and casein, respectively. Additionally, fat, suspended solids and nutrients (N and P) also contribute to the contamination levels. Without an appropriate treatment, these effluents pose serious environmental hazards. Biological and physicochemical processes are usually suggested to deal with dairy effluent (**Prazeres *et al.*, 2012; Carvalho *et al.*, 2013**). Cheese whey is defined as the greenish-yellow and/or whitish effluent generated in cheese making plants. The characteristics of cheese whey may significantly vary depending on the milk type, final products, agent type and valued whey volume (**Prazeres *et al.*, 2013**). *Schinus molle* L. is commonly known as Brazilian pepper tree. It is an evergreen tree belongs to family Anacardiaceae. It have been introduced and naturalized in many countries of the world as an ornamental species. Their successful introduction in a non-native range is attributed to their high drought and heat tolerance, great potential to compete for nutritive resources and light, high growth rate and prolific seed production, as well as, their phytotoxic activities (**Deveci *et al.*, 2010**). It grows rapidly at about 1m per year to a height of 20m with a corresponding trunk diameter that ranges from 30 to 80cm. It grows in a wide spectrum of soils from sandy to clayey, alkaline to saline. This tolerance range is in part due to an extensive radial and vertical root system, which can penetrate to 30m in depth. *S. molle* flowers are yellowish- to greenish-white, unisexual or hermaphroditic. The fruits are small red-purple in color; each contains one round seed that is maroon to black in color (**Ennigrou *et al.*, 2011**). *S. molle* is a tree of many uses. The wood is used for posts and interior floors, farm implements, rustic furniture, and home construction, because the wood burns slowly and emits uniform heat, it is considered a good fuel source. The tree's pendulant, informal branches and clusters of red-purple fruits add to its value as an ornamental. The fresh leaves, bark, and roots of the tree are used to alleviate or cure rheumatism, bronchial infections, high blood pressure, ulcers, tumors, anxiety, and inflammations of the skin **(Ennigrou *et al.*, 2011)**.

The aim of this study was to examine and evaluate the effect of irrigation using various types of cheese whey (CW) and potable water (PW) on *Schinus molle* L. seedlings growth and pigment contents.

Materials and Methods

Experiment procedures

This study was carried out at the experimental nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during two successive seasons of 2014/2015 and 2015/2016. *Schinus molle* L. seedlings were obtained from Green Valley nursery, Cairo, with an average height, diameter and number of leaves of 20cm, 6 mm (measured at 5cm from the soil surface) and 17, respectively. *Schinus molle* L. seedlings were transplanted on the first of March 2014 and 2015 in both seasons, in plastic pots (29, 23 and 27cm for the upper and lower inner diameters and height, respectively) filled with sandy soil (23kg) and left to grow in the pots for a month (one seedling/pot). The pots were placed in a sunny area and thick polyethylene sheets were spread underneath the pots to prevent the roots from penetrating into the soil. At the beginning of both growing seasons, all the plants received constant levels of Kristalon fertilization (NPK 20:20:20) at the rate of 5g/pot. The physical and chemical analysis of the planting soil and the chemical analysis of the different irrigation water types are presented in Tables 1, and 2 respectively.

Irrigation treatments

S. molle L. seedlings were irrigated manually on the first of April with cheese whey (CW) supplied from the Dairy Technology Unit of Faculty of Agriculture, Cairo University at the level of field capacity (700ml/pot). The ratio of irrigation treatments (CW: PT) used were as follows: PW (control) (0:1), Kareish cheese whey (KCW) (1:0) and (1:1), Mozzarella cheese non salty whey (MCNSW) (1:0) and (1:1), Mozzarella cheese salty whey (MCSW) (1:6) and (1:8), and Domiati cheese whey (DCW) (1:12) and (1:16).

Data collection and determination

Final harvest was conducted at the first of March in both seasons. Each seedling was separated into shoots (leaves and stems) and roots. The roots were washed with potable water to remove the remaining soil. Plant shoots were oven dried at 70°C to a constant weight for determining the dry weights. Vegetative growth traits (stem diameter (mm), main root length (cm), shoots and roots fresh weights (g), and shoots dry weight (g)) in addition to, pigments content in fresh leaf samples (chlorophyll *a*, *b* and total carotenoids (mg/g) according to **Lichtenthaler (1987)** using Spectrophotometer) were conducted.

Experimental design and statistical analysis

The layout of the experiment was a randomized complete block design. All treatments were replicated three times and 4 plants were used in each replicate (the total number of plants used per season were 108 seedlings). The analysis of variance of data (ANOVA) was carried out according to **Snedecor and Cochran (1982)** using **MSTAT- C (1989)** program based on the least significant difference (LSD) tested at $P \leq 0.05$.

Table 1. Averages of the physical and chemical analyses of the soil used for planting *Schinus molle* L. seedlings during first (2014/2015) and second (2015/2016) seasons.

Parameter	Average
Physical characteristics	
Texture class	sand
Sand (%)	99
Silt (%)	0.6
Clay (%)	0.4
pH	7.6
EC (dS/m)	2.00
$CaCO_3$	0.6
Organic matter (%)	0.1
Chemical characteristics	
Soluble Cations (meq/l)	
Ca^{++}	5.2
Mg^{++}	3.8
Na^{+}	10.9
K^{+}	0.1
Soluble Anions (meq/l)	
CO_3^{-}	-
HCO_3^{-}	5.6
Cl^{-}	9.00
SO_4^{--}	5.4
Available N (ppm)	0.05
Available P (ppm)	0.007

Table 2. Averages of the chemical analyses of the different water types used for irrigating *Schinus molle* L. seedlings during first (2014/2015) and second (2015/2016) seasons.

Parameters	Irrigation water types								
	PW (0:1)	Cheese whey types							
		KCW (1:0)	KCW (1:1)	MCNSW (1:0)	MCNSW (1:1)	MCSW (1:6)	MCSW (1:8)	DCW (1:12)	DCW (1:16)
pH	7.04	4.61	5.33	5.53	5.82	5.70	5.79	7.54	7.63
EC (dS/m)	0.32	2.94	1.52	4.37	2.53	6.60	5.41	4.84	4.28
SAR	1.75	4.35	4.40	5.19	4.23	8.46	9.45	8.42	7.16
***Soluble anions* (*mg/l*)**									
$HCO_3^- + CO_3^-$	1.43	9.16	5.76	16.37	9.10	17.73	14.22	14.62	13.62
Cl^-	2.13	16.54	7.41	19.86	12.22	44.19	31.13	28.28	24.17
SO_4^{--}	0.98	3.07	3.08	8.76	4.43	9.12	7.76	5.17	3.95
***Soluble cations* (*mg/l*)**									
Ca^{++}	1.01	8.74	4.23	12.43	7.48	17.75	11.82	16.23	14.22
Mg^{++}	0.96	5.23	2.01	9.67	5.13	11.14	7.54	4.19	3.55
Na^+	1.74	11.52	8.44	17.27	10.56	32.17	29.43	26.91	21.35
K^+	0.12	6.52	2.42	4.05	3.31	7.18	5.08	3.12	2.89
Total N (%)	0.14	1.86	1.12	2.16	1.43	0.97	0.86	0.74	0.68
Total P (%)	0.04	0.73	0.52	0.66	0.43	0.58	0.52	0.62	0.54
Turbidity (NTU)	0.3	46	29	70	36	44	39	42	27
TSS (ppm)	48	1812	1262	1544	1100	1344	1223	1310	1253
TDS (ppm)	204.8	1881.6	972.8	2796.8	1619.2	4224	3462.4	3097.6	2739.2
BOD (ppm)	12	33789	19254	31112	18620	14675	12943	11544	9689
COD (ppm)	57	55892	25132	45347	21541	15732	12433	13565	11187

TSS: Total Suspended solids
TDS: Total dissolved solids
BOD: Biochemical oxygen demand
COD: Chemical oxygen demand

Results and Discussion

Growth Traits:

Data presented in Tables 3 show the effect of different irrigation water types on growth characters of *S. molle* L. seedlings during two season 2014/2015 and 2015/2016. The results indicate that the growth parameter of plants irrigated with DCWW at 1:12 and 1:16, MCSWW at 1:6, and MCSWW at 1:8 increased gradually compared to the plants irrigated with potable water.

Stem diameter: During the first season irrigating with DCW (1:12) recorded a significantly increase in stem diameter followed by DCW (1:16) and MCSW (1:6) (11.76, 10.26, and 9.82mm), respectively. Whereas MCNSW (1:1) and KCW (1:1) recorded an insignificant increase (9.56 and 9.51mm), respectively. The thinnest stem diameter was insignificantly produced by MCSW (1:8) treatment (9.30mm). Whereas, the significantly thinnest stem diameter was produced by MCNSW (1:0) and KCW (1:0) treatments (8.30, and 7.93mm), respectively as compared to the control plants (9.39mm).

The biggest stem diameter in the second season was produced significantly by treating plants with DCW (1:12) followed by DCW (1:16) (11.93and10.35mm) and insignificantly with MCSW (1:6) and MCNSW (1:1) (9.94, and 9.83mm), respectively. The effect of irrigation of *S. molle* plants with MCSW (1:8) gave insignificantly the lowest stem diameter followed by KCW (1:1) (9.68, 9.13mm) and significantly with MCNSW (1:0) and KCW (1:0) (8.17, and 7.90mm), respectively as compared to control plants (9.29mm).

The reason of the biggest stem diameter in plants irrigated with DCW at 1:12 and1:18 and MCSW at 1:6 and 1:8 may be due to that plants absorbed their full needs of nutrients and organic matter that helped in modifying the growth better than the other treatments **(Ali *et al*., 2011).** Treating plants with MCNSW at 1:1, KCW at 1:1 and 1:0, and MCNSW at 1:0 those contained higher concentrations of nutrients that exceeded the plants' needs, decreased the stem diameter as compared to control **(Elgallal *et al*., 2016).**

The results were in agreement with those obtained **Al-Absi (2008)** who treated *Olea europaea* L. with industrial effluent wastewater the results showed the biggest stem diameter of plants irrigated with wastewater as compared to the plants treated with potable water. **Ali *et al*. (2011)** on *Swietenia mahogoni* and **Ali *et al*. (2012)** on *Tipuana speciosa* (Benth.) Kuntze seedlings indicated that primary effluent treatment was superior to secondary effluent and potable water for improving stem diameter. **Goncalves *et al*. (2017)** on sugarcane found that irrigation with treated domestic sewage recorded the largest stem of sugarcane.

Root length: In the first season, DCW at 1:12 followed by DCW at 1:16, MCSW at 1:6, and MCSW at 1:8 treatments produced *S. molle* seedlings with the significantly longest roots (40.22, 38.67, 35.78, and 34.50cm/plant, respectively). Whereas; the insignificantly shortest roots were presented from plants irrigated with MCNSW at 1:1 (32.22cm/plant). Seedlings irrigated with MCNSW at 1:0, KCW at 1:1, and 1:0 treatments were significantly shorter than the control (32.94cm/plant), with means length 32.00, 30.94, and 31.83cm/plant, respectively.

The second season showed a similar trend. Irrigating plants with DCW (1:12) followed by DCW (1:16), MCSW (1:6), and MCSW (1:8) produced the significantly longest roots length (40.17, 38.56, 35.33, 34.56cm/plant, respectively). Treating *S. molle* seedlings with MCNSW (1:0) followed by MCNSW (1:1), and KCW (1:0) gave the insignificantly shortest roots length with means of 32.44, 32.22, and 32.06cm/plant, respectively. Whereas, the significantly decrease in roots length was presented by KCW (1:1) treatment (30.39cm/plant) in the comparison with untreated plants (32.89cm/plant).

The effects of deferent CW types on roots length may be due to roots accumulated a nutrients in the form of their needs applied to their zones by DCW (1:12), DCW (1:18), MCSW (1:6) and MCSW (1:8) treatments. These elements enhance the cell division and lead to increment in roots length.

The results agreed with the findings of **Kumar and Reddy (2010)** on *Casuarina equisetifolia*, **Zalensy and Zalensy (2011)** on twelve Populus clones who reported that irrigation of plants with wastewater effluent enhanced root length.

Shoots fresh weight: In the first season, irrigation of *S. molle* with DCW at 1:12 significantly recorded the heaviest shoots fresh weight followed by DCW (1:16), MCSW (1:6), and MCSW (1:8) recorded (46.15, 44.08, 39.78, and 37.08g/plant), respectively. The lowest values were produced with plant irrigation with MCNSW (1:1) followed by MCNSW (1:0) KCW (1:1), and KCW (1:0) with weight means of (33.71, 32.22, 31.42, and 30.93g/plant), respectively compared to the plants irrigated with PW (34.74g/plant).

Treating plants with different CW types showed the highest plant weight values significantly obtained from those irrigation with DCW (1:12) followed by DCW (1:16), MCSW (1:6), and MCSW (1:8) with means of 45.78, 43.94, 39.39, and 37.16g/plant, respectively. Meanwhile, the lowest significantly plant weight values were obtained from those irrigated with MCNSW (1:1) followed by MCNSW (1:0), KCW (1:1), and KCW (1:0) (34.28, 32.51, 31.33, 30.56g/plant) as compared to untreated plants (34.85g/plant) during the second season.

The present of nutrients and organic matter of DCW (1:12), DCW (1:18), MCSW (1:6) and

MCSW (1:8) treatments may help in increasing the photosynthetic process and consequently more carbohydrates accumulation and as a result high values of shoots fresh weight **(El-Nahhal *et al*., 2013)**.

The results were in agreement with those obtained by **Shah *et al*. (2010)** on *Eucalyptus camaldulensis* who indicated that the difference in growth and biomass production under different sources of wastewater application may be due to variations in chemical constitutes through effluents therefore, high leaf biomass obtained. **Ali *et al*. (2012)** on *Tipuana speciosa* (Benth.) Kuntze seedlings indicated that plants irrigated with the primary effluent significantly gave the heaviest leaves fresh weight more than control plants. **El-Nahhal *et al*. (2013)** indicated that leaves fresh weight of Chinese cabbage in plots irrigated with treated wastewater is higher than those irrigated with fresh water. **Prazeres *et al*. (2016)** found that tomato cultivar (Rio Grande) irrigated with five different cheese whey wastewater gave increments in fruit fresh weight. The decrease of leaves fresh weights are also in agreement with the findings of **Hashem *et al*. (2013)** on turnip, tomato; lettuce. The results showed a significant decrease in fresh weight of leaves when plants irrigated with industrial wastewater.

Roots fresh weight: In the first season, *S. molle* fresh weights were increased significantly by the irrigation with DCW (1:12), DCW (1:16), and MCSW (1:6) treatments (46.94, 43.99, and 40.99g/plant, respectively) and insignificantly with MCSW (1:8) (37.06g/plant). The significantly decrease in roots fresh weights were produced by MCNSW (1:1), MCNSW (1:0), KCW (1:1), and KCW (1:0) recording 31.55, 27.75, 25.83, 24.14g/plant, respectively as compared to the plants irrigated with PW (36.25g/plant).

During the second season, the heaviest root fresh weights were significantly shown by DCW (1:12) followed by DCW (1:16), and MCSW (1:6) (46.38, 43.97, and 40.98g/plant, respectively). The insignificantly increase in weights were presented by MCSW (1:8) (37.08g/plant) compared to untreated plants (36.42g/plant). *S. molle* plants irrigated with MCNSW (1:1) followed by MCNSW (1:0), KCW (1:1), and KCW (1:0) produced the lightest fresh weight of roots recording 31.20, 27.86, 25.76, 24.39g/plant, respectively as compared to the control plants (36.42g/plant).

Such results may be reasonable, as the marked difference in growth and biomass production under different sources of wastewater application may be due to variations in chemical constituents, particularly metal ions. Thereof, high root biomass in the trees is obviously due to addition of N through sewage effluent **Shah *et al*. (2010).**

The results are in harmony with the findings of **Hassan *et al*. (2008)** on *Taxodium distichum* and **Shah *et al*. (2010)**, who reported that plants irrigation with different sewage effluents enhanced the fresh weight of roots. **Ali *et al*. (2012)** on *Tipuana speciosa* (Benth.) Kuntze seedlings indicated that plants irrigated with the primary effluent significantly gave the heaviest root fresh weight more than plants treated with potable water.

Shoots dry weight: During the first season, the significantly heaviest shoots dry weights were produced with plants treated with DCW (1:12) followed by DCW (1:16), MCSW (1:6), and MCSW (1:8) with means weight (14.79, 14.41, 12.75, and 11.82g/plant, respectively). The lowest significantly dry weight of leaves/plant were presented by plants irrigating with MCNSW (1:1) followed by MCNSW (1:0), KCW (1:0), and KCW (1:1) (10.80, 10.66, 9.19, and 8.83g/plant, respectively) compared to the control plants (11.47g/plant).

Shoots dry weight, in the second season, was significantly increased by irrigating plants with DCW (1:12), DCW (1:16), MCSW (1:6), and MCSW (1:8) with means of (14.92, 14.37, 12.71, and 11.89g/plant, respectively). On the other hand, the lowest significantly value of shoots dry weight was showed by plants treated with MCNSW (1:1) followed by MCNSW (1:0), KCW (1:0), and KCW (1:1) (10.78, 10.55, 9.36, 8.77g/plant, respectively) as compared with the control plants with means weight 11.49g/plant.

The increase of shoots dry weight may be due to the increase of whey contents of macro and micro elements which helped in improving the plant height and in turn reflected on a good fresh and dry shoot weights in plants during both seasons.

Many workers obtained the similar results **Ali *et al*. (2012)** on *Tipuana speciosa* (Benth.) Kuntze seedlings indicated that plants irrigated with the primary effluent significantly gave the heaviest leaves fresh weight more than plants treated with potable water. **Elsokkary and Abukila (2014)** on four types of plants soybean (*Glycine max* L.), corn (*Zea mays* L.), faba bean (*Vicia faba*) and wheat (*Triticum aestivum* L.) who showed treating plants with wastewater attained the greatest increase in leaves dry weight as compared to well water.

Pigments content

Data presented in Tables 4 show the effects of different irrigation water types on pigments content of *S. molle* L. seedlings during seasons of 2014/2015 and 2015/2016. The results indicated that pigments content in plants irrigated with DCWW at ratios of 1:12 and 1:16 and MCSWW at ratios of 1:6 and 1:8 increased gradually compared to the plants irrigated with potable water.

Chlorophyll *a*: It is clear from the results that the highest content of chlorophyll *a* was significantly found in leaves of plants irrigated with DCW (1:12) (0.71mg/g) followed by DCW (1:16) and MCSW (1:6) (0.64mg/g). An insignificantly increase were presented by MCNSW (1:1), MCNSW (1:0), MCSW (1:8), and KCW (1:1) with means of 0.53, 0.50, 0.49, and 0.49mg/g, respectively. Treated *S. molle* plants with KCW (1:0) recorded the insignificantly lowest content of chlorophyll *a* (0.40 mg/g) as compared to the control plants (0.45mg/g) in the first season.

In the second season, irrigating *S. molle* plants with DCW (1:12), DCW (1:16), MCSW (1:6), MCNSW (1:1), MCNSW (1:0), and KCW (1:1) gave significantly the highest content of chlorophyll *a* with means of 0.71, 0.63, 0.63, 0.57, 0.50, and 0.50mg/g, respectively. On the other hand, treating plants with MCSW (1:8) gave an insignificantly high content of chlorophyll *a* (0.48mg/g). The lowest significant content of chlorophyll *a* showed in plants irrigated with KCW (1:0) (0.39mg/g) as compared to the control plants (0.44 mg/g).

Chlorophyll *b*: In the first season, chlorophyll *b* content showed a significantly increase by irrigating plants with DCW (1:12), DCW (1:16), and MCSW (1:6). Chlorophyll *b* contents recorded 1.03, 0.97, and 0.86mg/g, respectively. The insignificantly values were presented by plants irrigated with MCNSW (1:1), MCSW (1:8), KCW (1:1), and KCW (1:0) with means of 0.64, 0.57, 0.55, and 0.55mg/g, respectively. Irrigating *S. molle* with MCNSW (1:0) gave the insignificantly lowest content of chlorophyll *b* with mean of 0.39mg/g as compared to untreated plants (0.52mg/g).

During the second season, the significantly highest content of chlorophyll *b* were shown by plants treated with DCW (1:12), DCW (1:16), and MCSW (1:6) whereas, the insignificantly contents were in plants treated with MCNSW (1:1), KCW (1:1), MCSW (1:8), and KCW (1:0) (1.15, 1.03, 0.85, 0.58, 0.56, 0.55, and 0.55mg/g, respectively). On contrary the lowest content of chlorophyll *b* were produced insignificantly in plants irrigated with MCNSW (1:0) (0.40mg/g) as compared to untreated plants (0.49mg/g).

The increase in Chlorophyll *a* and *b* contents by DCW (1:12), DCW (1:18), MCSW (1:6) and MCSW (1:8) irrigation treatments may be due to the increase in nutrient levels those have positive impacts on leaves chlorophyll contents (**Herteman *et al*., 2011**). While irrigation with MCNSW (1:1), KCW (1:1), KCW (1:0), and MCNSW (1:0) those contained higher concentrations of nutrients that exceeded the plants' needs led to reduction in chlorophyll contents **(Elgallal *et al*., 2016).**

The results agreed with those obtained by **Shah *et al*. (2010)** on *Eucalyptus camaldulensis* and **Herteman *et al*. (2011)** on *Rhizophora mucronata* and *Ceriops tagal* reporting that high content of total chlorophyll in plant parts results from the irrigation with different types of wastewater. **Gupta *et al*. (2010)** showed that the decrease in total chlorophyll in *Colocasia esculentum*, *Brassica nigra*, and *Raphanus sativus* plants were presented by wastewater irrigation.

Total carotenoids: Treating *S.molle* plants with DCW (1:12) increased significantly the carotenoids content (0.59mg/g) followed by DCW (1:16) (0.56mg/g), and MCSW (1:6) (0.49mg/g) and insignificantly with MCSW (1:8) (0.39mg/g), KCW (1:1) (0.36mg/g), and MCNSW (1:1) (0.32mg/g). On the other hand, treating plants with MCNSW (1:0) and KCW (1:0) had the lowest insignificantly content of carotenoids with the same mean (0.30mg/g) as compared to the control plants (0.32mg/g), in the first season.

During the second season, the highest significantly content of carotenoids were shown in plants irrigating with DCW (1:12) followed by DCW (1:16), and MCSW (1:6), with carotenoid contents of 0.62, 0.52, and 0.49mg/g, respectively while, a high insignificantly content with MCSW (1:6) (0.36mg/g). The lowest insignificantly content of carotenoids produced by irrigating *S. molle* with MCNSW (1:1) and MCNSW (1:0), with carotenoid contents of 0.32, and 0.32mg/g. The significantly low values were presented by KCW (1:0) and KCW (1:1) (0.29, and 0.25mg/g) as compared to the control plants (0.33mg/g).

These results are reasonable as DCW (1:12), DCW (1:18), MCSW (1:6) and MCSW (1:8) have essential nutrients and organic matter that enhance photosynthetic and metabolic processes that cause more carotenoids accumulation (**Herteman *et al*., 2011**). On the other hand, treating plants with MCNSW (1:1), MCNSW (1:0), KCW (1:0), and KCW (1:1) those contained higher concentrations of nutrients that exceeded the plants' needs, decreased carotenoids contents **(Elgallal *et al*., 2016).**

These results were in agreement with those obtained by **Ali *et al.* (2011)** on *Swietenia mahogoni* and **Herteman *et al*. (2011)** on *Rhizophora mucronata* and *Ceriops tagal* mangrove trees, who found that carotenoids content in the leaves of plant treated with wastewater were increased compared to those irrigated with potable water.

Table 3. Effect of different irrigation water types on growth characters of *Schinus molle* L. seedlings during first (2014/2015) and second (2015/2016) seasons.

Treatments	2014/2015					2015/2016				
	Stem diameter (mm)	Main root length (cm/plant)	Shoots fresh weight (g/plant)	Roots fresh weight (g/plant)	Shoots dry weight (g/plant)	Stem diameter (mm)	Main root length (cm/plant)	Shoots fresh weight (g/plant)	Roots fresh weight (g/plant)	Shoots dry weight (g/plant)
PW (control) (0:1)	9.39	32.94	34.74	36.25	11.47	9.29	32.89	34.85	36.42	11.49
KCW (1:0)	7.93	31.83	30.93	24.14	9.19	7.90	32.06	30.56	24.39	9.36
KCW (1:1)	9.30	30.94	31.42	25.83	8.83	9.13	30.39	31.33	25.76	8.77
MCNSW (1:0)	8.30	32.00	32.22	27.75	10.66	8.17	32.44	32.51	27.86	10.55
MCNSW (1:1)	9.56	32.22	33.71	31.55	10.80	9.83	32.22	34.28	31.20	10.78
MCSW (1:6)	9.82	35.78	39.78	40.99	12.75	9.94	35.33	39.39	40.98	12.71
MCSW (1:8)	9.51	34.50	37.08	37.06	11.82	9.68	34.56	37.16	37.08	11.89
DCW (1:12)	11.76	40.22	46.15	46.94	14.79	11.93	40.17	45.78	46.38	14.92
DCW (1:16)	10.26	38.67	44.08	43.99	14.41	10.35	38.56	43.94	43.97	14.37
LSD	**0.38**	**0.80**	**0.12**	**0.82**	**0.35**	**0.74**	**0.94**	**0.11**	**0.89**	**0.41**

Table 4. Effect of different irrigation water types on pigments content of *Schinus molle* L. seedlings during first (2014/2015) and second (2015/2016) seasons.

Treatments	2014/2015			2015/2016		
	Chlorophyll *a* (mg/g)	Chlorophyll *b* (mg/g)	Total carotenoids (mg/g)	Chlorophyll *a* (mg/g)	Chlorophyll *b* (mg/g)	Total carotenoids (mg/g)
PW (control) (0:1)	0.45	0.52	0.32	0.44	0.49	0.33
KCW (1:0)	0.40	0.55	0.30	0.39	0.55	0.29
KCW (1:1)	0.49	0.55	0.36	0.50	0.56	0.25
MCNSW (1:0)	0.50	0.39	0.30	0.50	0.40	0.32
MCNSW (1:1)	0.53	0.64	0.32	0.57	0.58	0.32
MCSW (1:6)	0.64	0.86	0.49	0.63	0.85	0.49
MCSW (1:8)	0.49	0.57	0.39	0.48	0.55	0.36
DCW (1:12)	0.71	1.03	0.59	0.71	1.15	0.62
DCW (1:16)	0.64	0.97	0.56	0.63	1.03	0.52
LSD	**0.05**	**0.16**	**0.05**	**0.05**	**0.12**	**0.05**

Conclusion

According to this study it is concluded that: (1) cheese whey availability and its nutrient and organic matter contents make it a valuable alternative water supply for irrigation practice in arid and semi-arid zones, (2) irrigation by using different types of cheese whey at different ratios have positive effects on growth and pigment contents of *S. molle* L. seedlings, (3) using CW in irrigating ornamental plant can help in protecting the environment and controlling pollution, in addition to, (4) using CW for irrigation reduces fertilizer applications and increase productivity of poorly fertile soils.

References

Al-Absi, K. M. (2008). Effect of irrigation with treated industrial effluent on growth and biochemical constituents of olives. Bulgarian Journal of Agricultural Science, 14(6): 564-575**.**

Ali, H.M.; El-Mahrouk, E.M.; Hassan, F.A. and El-Tawary, M.A. (2011). Usage of sewage effluent in irrigation of some woody trees plants. Part 3: *Swietenia mahogni* (L.) Jacq. Saudi J. Biological Sci., 18: 201-207.

Ali, H.M.; Khamis, M.H. and Hassan, F.A. (2012). Growth, chemical composition and soil properties of *Tipuana speciosa* (Benth.) Kuntze seedlings irrigated with sewage effluent. Appl Water Sci., 2: 101-108.

Carvalho, F.; Prazeres, A.R. and Rivas, J. (2013). Cheese whey wastewater: Characterization and treatment. Science of the Total Environment, 445-446: 385-396.

Deveci, O.; Sukan, A.; Tuzun, N. and Kocabas, E.E.H. (2010). Chemical composition, repellent and antimicrobial activity of *Schinus molle* L**.** Journal of Medicinal Plants Research, 4(21): 2211-2216.

Elgallal, M.; Fletcher, L. and Evans, B. (2016). Assessment of potential risks associated with chemicals in wastewater used for irrigation in arid and semiarid zones: A review. Agricultural Water Management, 177: 419-431.

El-Nahhal, Y.; Tubail, K.; Safi, M. and Safi, J. (2013). Effect of treated wastewater irrigation on plant growth and soil properties in Gaza strip, Palestine. American Journal of Plant Sciences, 4: 1736-1743.

Elsokkary, H.I. and Abukila, A.F. (2014). Risk assessment of irrigated lacustrine and calcareous soils by treated wastewater. Water Science, 28: 1-17.

Ennigrou, A.; Hosni, K.; Casabianca, H.; Vulliet, E. and Smiti, S. (2011). Leaf volatile oil constituents of *Schinus terebinthifolius* and *Schinus molle* from Tunisia. Journal of Environmental Management, 110: 48-68.

Goncalves, I.Z.; Barbosa, E.A.A.; Santos, L.N.S; Nazário. A.A.; Feitosa, D.R.C.; Tuta, N.F. and Matsura, E.E. (2017). Water relations and productivity of sugarcane irrigated with domestic wastewater by subsurface drip. Agricultural Water Management, 185: 105-115.

Gupta, S.; Satpati, S.; Nayek, D. and Garai, D. (2010). Effect of wastewater irrigation on vegetables in relation to bioaccumulation of heavy metals and biochemical changes. Environ. Monit. Assess., 165: 169-177.

Hashem, H.A.; Hassanein, R.A.; El-Deep, M.H. and Shouman, A.I. (2013). Irrigation with industrial wastewater activates antioxidant system and osmoprotectant accumulation in lettuce, turnip and tomato plants. Ecotoxicology and Environmental Safety, 95:144-152.

Hassan, F.A.; Mahrouk, E.M.; El-Tawary, M.A. and Ali, H.M. (2008). Usage of sewage effluent in irrigation of some woody tree plants (*Taxodium distichum* Rish.) Proc.l[st] Int. Sci. Conf. on ornamentals March 2-3 (Alexandria). Alex. J. Agric. Res., 53: 55-65.

Herteman, M.; Fromard, F. and Lambs, L. (2011). Effects of pretreated domestic wastewater supplies on leaf pigment content, photosynthesis rate and growth of mangrove trees: A field study from Mayotte Island, SW Indian Ocean. Ecological Engineering, 37: 1283-1291.

Kumar, Y.A. and Reddy, V.M. (2010). Effect of municipal sewage on the growth performance of *Casuarina equisetifolia* on sandy soil of east cost at Kalpakkam. Applied Ecology and Environ. Res., 8(1): 77-85.

Lichtenthaler, H.K (1987). Chlorophylls and carotenoids: pigments of photosynthetic biomembranes. Meth. Enzym., 148: 350-382.

Prazeres, A.R.; Carvalho F.; Rivas, J. (2012). Cheese whey management: A review. Journal of Environmental Management, 110: 48-68.

Prazeres, A.R.; Carvalho, F.; Rivas, J.; Patanita, M. and Dôres, J. (2013). Pretreated cheese whey wastewater management by agricultural reuse: Chemical characterization and response of tomato plants *Lycopersicon esculentum* Mill. under salinity conditions. Science of the Total Environment, 463-464: 943-951.

Prazeres, A.R.; Rivas, J.; Almeida, M.A.; Patanita, M.; Dôres, J. and Carvalho, F. (2016). Agricultural reuse of cheese whey wastewater treated by NaOH precipitation for tomato production under several saline conditions and sludge management. Agricultural Water Management, 167: 62-74.

Shah, F.U.R.; Ahmad, N.; Masood, K.R.; Peralta-Videa, J.R.; Zahid, D.M. and Zubair, M. (2010). Response of *Eucalyptus camaldulensis* to irrigation with the hudiara drains effluent. International Journal of Phytoremediation, 12: 343-357.

Snedecor, G.A. and Cochran, W.G. (1982). Statistical Method. Lowa state Univ. Press, Ames, Low, pp. 88-91.

Zalensy, R.S. and Zalensy, J.A. (2011). Clonal variation in lateral and basal rooting of *Populus* spp. Irrigated with landfill leachate. Silvae Genetica, 60(1): 35-44.

إستجابة شتلات الفلفل الرفيع للرى بشرش الجبن

طارق أبودهب محمد أبودهب, أميرة فتحى يوسف القاضى, سحر ثابت عبد الحفيظ عويس

قسم بساتين الزينة, كلية الزراعة, جامعة القاهرة, الجيزة, مصر

صناعات الألبان احد المصادر الرئيسية لمياه الصرف الصناعى, هذه الصناعة قائمة على تجهيز وتصنيع اللبن الخام إلى منتجات مختلفة مثل الجبن. يعتبر شرش الجبن من المخلفات السائلة الغنية بالمواد العضوية. نفذت هذه الدراسة لتقييم تأثير الرى بإستخدام أنواع مختلفة من شرش الجبن ومياه الشرب على النمو والمحتوي من الصبغات لشتلات الفلفل الرفيع. أجريت التجربة فى مشتل قسم بساتين الزينة, كلية الزراعة, جامعة القاهرة, خلال موسمي 2014/ 2015 و 2015/ 2016. تصميم التجربة هو تصميم القطاعات الكاملة العشوائية وإستخدمت فيها تسعة معاملات كما يلى: ماء الشرب (الكنترول) (0: 1), شرش جبنة قريش (1: 0) و (1: 1), شرش جبنة موزاريلا غير مالح (1: 0) و (1: 1), شرش جبنة موزاريلا مالح (1: 6) و(1: 8), و شرش جبنة دمياطى (1: 12) و (1: 16). تم قياس صفات النمو (قطر الساق (مم), طول الجذر الرئيسى (سم), الوزن الطازج للمجموع الخضرى والجذرى (جم), الوزن الجاف للمجموع الخضرى (جم)) بالإضافة إلى تقدير محتوى النبات من الصبغات (كلوروفيل أ , ب, و الكاروتينات الكلية (مجم/ جم)). أوضحت النتائج أن رى النباتات بشرش الجبنة الدمياطى (1: 12) و (1: 16) و شرش الجبنة الموزاريلا المالح (1: 6) و (1: 8) سجلت أعلى معنوية للنمو والمحتوى من الصبغات عن النباتات المروية بشرش كل من الجبنة الموزاريلا الغير مالح و الجبنة القريش وذلك مقارنة بالكنترول فى الموسمين. طبقا للنتائج يتضح أن إستخدام الأنواع المختلفة من شرش الجبن يعتبر طريقة إقتصادية لحل مشاكل نقص المياه.