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USAGE OF SANITARY WATER FOR PRODUCTION OF SOME CUT-FLOWERS

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ABSTRACT

Two pot experiments were carried out at the Experimental Station of Vegetable and Floriculture Department, Faculty of Agriculture, Mansoura University during the seasons of 2005 and 2006 to reveal the effect of irrigation with primary treated sanitary water (chlorinated and non-chlorinated) on growth, flowering, production and quality of the produced flowers, as well as, chemical composition of both bird-of-paradise (*Strelitzia reginae* Ait.) and carnation (*Dianthus caryophyllus* L.) plants grown in clayey soil under full sun conditions. Public hazards impact through the pathogenic indicator microorganisms and human parasites in water, plant, cut-flowers and soil were also evaluated.

The obtained results indicated that using of chlorinated sanitary water for irrigation of either bird-of-paradise or carnation plants significantly improved some parameters of vegetative growth, bird-of-paradise clump fresh and dry weights, only dry weight of carnation roots, as well as, inducing the greatest precocity in flowering of both plants, which was accompanied with some quality traits of the produced cut-flowers and increasing of vase-life. Moreover, the chemical constituents in the leaves of both plants and in bird-of-paradise rhizomes were significantly increased with few exceptions.

The pathogenic indicator bacteria (total and fecal coliform), salmonella & shigella and helminthes (*Emobiae histylotica* and ascaris ova) were not detected in the plants, resulted cut-flowers, beside the used water and soil due to chlorination treatment. On the other hand, the least means in all previously mentioned parameters were, in most cases, due to irrigation with non-chlorinated sanitary water, which led also to infection of the plants, the soil and the obtained cut-flowers with some pathogens and parasites.

So, to exploit the primary treated sanitary water for production of bird-of-paradise and carnation cut-flowers in a safe manner, it is necessary to chlorinate such water with 2.5 g Cl/m^3 of water flow.

INTRODUCTION

Until now, production of commercial cut-flowers for either local consumption or exportation is still one of the most important ways for improving our National Income, making the best flower arrangements and beautifying flower beds and the closed places. Among important cut-flowers commercially used for various purposes may be bird-of-paradise and carnation.

Strelitzia reginae Ait., bird-of-paradise, Queen's bird-of-paradise or Crane flower (Fam. Strelitziaceae), is a herb lacking evident stem (trunkless), up to 90-100 cm height; clump forming; leaves oblong-lanceolate, 2-ranked, up to 45-50 cm long, 15 cm wide, acute, glaucescent beneath; flowers in a rigid, boat like bract on lateral, compound inflorescence, orange or yellow with a dark blue tongue. Native to South Africa. Suitable for warm climates or for growing under glass in tubs with a night temperature of 10 ^{0}C. Propagation by suckers, division and seeds (Bailey, 1976).

Another important one is *Dianthus caryophyllus* L., carnation (Fam. Caryophyllaceae), it is a cespitose perennial herb, glaucous; short-lived; stem stiffy erect, up to 90-100 m length; leaves in pairs and usually united at the base forming a conspicuous sheath around the stem, chonnelled, acuminate, bluish-glaucous, 7.5-15 cm long; the nodes are usually swollen; flowers solitary or panicled, long-stalked, 5-10 cm across, often double and sometimes fragrant, the modern cultivars flower all the year round with a great range of colours which comprises white, pink, red, purple, yellow, apricot-orange and white spotted red. Native to Mediterranean region, widely cultivated elsewhere by florists, also grown for use in perfumes. Propagation by cuttings, layers or division (Bailey, 1976).

Due to the scarcity of water resources, and the increasing demand of excess water, particularly at the Middle East Region which suffers from aridity and tremendous population, exploitation of waste water for irrigation of ornamental plants, which are not food chain crops, may be a suitable economic solution for its disposal and alleviate the water shortage problem. In this concern, Nancy-Ebner *et al*. (1999) found that irrigation of *Minneola tangelo* and carnations with treated sewage water resulted in an improvement in nutritional status of the soil and foliage, due to an increase in nitrogen. This resulted in increased budding and flowering. Hunshal *et al*. (2000) indicated that growers using sanitary water for cut-flowers production had some advantages included increases of 25-50% in yield, lower fertilizer input, protection from erratic rainfall conditions and the 3- to 5-fold increases in market prices in the off-season because the contents of suspended solids, solutes and total N were high. Significant increases in height, branch and leaf numbers, fresh and dry weights, as well as, flower production were also obtained by Wu *et al*. (1995) on *Hydrangea macrophylla*, *Rosa sempervirens*, *Jasminum sambac* and *Azalea formosa*, Atzmon *et al*. (1997) on *Bougainvillea glabra*, Pinamonti *et al*. (1997) on *Gerbera jamesonii* and Nirit *et al*. (2006) who stated that the visible appearance, growth, number and length of the flowering stems and their post-harvest performance of roses and other cut-flowers were improved by irrigation with secondary treated sewage water. Contents of macro elements in the leaf tissues were unaffected by the use of such water, whereas Cl, Mn, Cu und B contents were increased.

On the other hand, reuse of waste water for irrigation proved to have some disadvantages. In this connection, Gogate *et al*. (1995) reported that wood density, ring width and fiber length of teak (*Tectona grandis*) tree irrigated with sewage effluent were not as good as those of ones irrigated with fresh water. Likewise, Hunshal *et al*. (2000) on amaranthus postulated that deleterious effects of sanitary water include potential contamination by total and fecal coliform bacteria, prevalence of conjunctivitis and dermatological diseases, al well as, incidence of weeds and pests infestation. Norman *et al*. (2003) revealed that Erwinia soft-rot (synonym Pectobacterium) caused extensive crop losses in production of ornamental plants belong to Fam. Araceae. However, all previous beneficial and harmful effects were also emphasized by Wallace *et al*. (1979) on chrysanthemum, Vasseur *et al*. (1996) on conifers, Shahin *et al*. (2002) on ryegrass, Shahin and Abdel-Salam (2005) on seashore paspalum, Shahin and Boraas (2005) on

Dodonaea viscosa and Hassan *et al*. (2006) on *Taxodium distichum*, *Albizzia lebbeck* and *Tipuana speciosa*.

This work aims to study the different effects of sanitary water on growth behaviour, production and quality of cut-flowers, as well as chemical composition of bird-of-paradise and carnation plants, and to detect the incidence of biological contamination with both fecal coliform and parasites in the used plants and soil.

MATERIALS AND METHODS

The present study was conducted in the open under full sun at the Experimental Station of Vegetable and Floriculture Department, Faculty of Agriculture, Mansoura University during 2005 and 2006 seasons to elicit the response of bird-of-paradise and carnation plants that were obtained freshly for every season from the nursery of Orman Botanic Garden in Giza to irrigation with either chlorinated or non-chlorinated primary treated sanitary water.

So, two-years-old plants of *Strelitzia reginae* Ait. which carry about 7-8 leaves and have a clump contains 7-8 rhizomes (rootstalks) were transplanted on April, 1^{st} for both seasons into 50-cm-diameter black polythene bags (one plant/bag) filled with 25 kg of clayey soil, which its physical and chemical properties are shown in Table (a). In addition, rooted terminal shoot cuttings of *Dianthus caryophyllus* L., cv. Gigi 10-12 cm long with 5-6 pairs of leaves were planted also on April 1^{st} in 20-cm-diameter clay pots (one rooted cutting/pot) filled with 2.5 kg of the same clayey soil used in case of bird-of-paradise (Table, a). One month after planting (on May 1^{st}), carnation transplants were stopped back by pinching the stem tip once. Of the shoots which grew out as a result of pinching, only the uppermost two were retained, while the others were removed at an early stage. The plants were examined each week to remove all the lateral buds large enough by hand (using thumb and forefinger), except the terminal bud. To keep the growing stems upright, the plants were supported with 1-m-long pieces of ditch reed using tulle stripes to tie the stems to such stakes. Water was given once every three days throughout the course of this study with enough quantity (5 L/bag for bird-of-paradise and 500 ml/pot for carnation) of the following three different water qualities:

1- Fresh water (E.C. = 0.42 dS/m) referred to as control.
2- Primary treated sanitary water obtained from Mansoura Waste Water Treatment Plant, Mansoura, Dakahliya Governorate, referred to as (P.T.S.W.).
3- Primary treated and chlorinated sanitary water (2.5 g Cl/m^3 of water flow), referred to as (P.T.C.S.W.).

The chemical properties and pathological characteristics in samples of the used sanitary water during the two seasons (either P.T.S.W. or P.T.C.S.W.) are shown in Tables (b) and (c). Concentrations of some heavy metals in the used sanitary water, as indicated in Table (b), were generally lower than those recommended by FAO (1986).

Table (c): Detection of pathogenic indicators and human parasites in samples of the used sanitary water during 2005 and 2006 seasons

Pathological characteristics	Detection			
	P.T.S.W.		P.T.C.S.W.	
	2005	2006	2005	2006
Pathogenic indicators				
Total coliform bacteria	d.	d.	n. d.	n. d.
Fecal coliform bacteria	d.	d.	n. d.	n. d.
Salmonella & Shigella	n. d.	n. d.	n. d.	n. d.
Human parasites				
Emobiae histylotica Cyst.	d.	d.	n. d.	n. d.
Giardia lamblea	d.	d.	n. d.	n. d.
E. coli, Round & Hookworms	d.	d.	n. d.	n. d.

*** d.: detected** *** n. d.: not detected**

All plants under various treatments received all the normal agricultural practices whenever needed, with the exception of fertilization. The layout of the experiments in the two seasons was a complete randomized design (Mead *et al*., 1993) for each crop alone with three replicates as each replicate included six plants.

One week before termination of the experiments (Oct., 30^{th} for the two seasons), fresh leaf samples from the different treatments in the second season only, were taken from the middle parts of the two crops to determine pigments content (chlorophyll a, b and carotenoids as mg/g fresh weight) according to Moran (1982). At the end of the experiments, however, the following data were recorded: plant height (cm), leaf No./plant, petiole length and diameter at the base (cm), lamina length and width (cm) and aerial parts fresh and dry weights (g) for bird-of-paradise plant, while for carnation, they were: stem length (cm) and diameter at the base (mm), No. internodes/stem, internode length (cm), No. leaf pairs/stem, leaf length (cm), as well as, top growth and roots fresh and dry weights (g). At starting of flowering of both plants, No. days from planting to first flower opening (day) was counted. In addition, peduncle length and diameter at the base (cm), No. flowers/inflorescence and No. inflorescences/plant were determined for bird-of-paradise plant, but in case of carnation, the registered flowering data were: flower diameter (cm), No. petals/flower, stalk length (cm) which was cut directly above the fourth node from down, No. flowers/plant and mean flower fresh and dry weights (g). Vase-life (days) was measured for both plants. Since bird-of-paradise plant give rhizomatous clump, No. rhizomes/clump and clump fresh and dry weights (g) were monitored in the two seasons.

In dry leaf samples taken from both studied plants, as well as, dry samples from bird-of-paradise rhizomes in the 2^{nd} season only, total carbohydrates as mg/g dry weight after Herbert *et al*. (1971), N, P and K as percentages, as well as, Pb and Cd as ppm according to Jackson (1973) were assessed. Moreover, samples from the two plants, cut-flowers of both and the soil irrigated with different water qualities were also taken at the end of the second season for pathological analysis according to APHA (1989).

Data were then tabulated and statistically analyzed, with the exception of chemical and pathological analyses, according to SAS program (1994) using Duncan's Multiple Range Test (1955) to elucidate the significancy level among various treatments.

RESULTS AND DISSCUSION

A. Effect of water quality on vegetative growth, flowering, clump productivity, chemical composition and pathological analysis of *Strelitzia reginae* Ait. plant:

1. Effect on vegetative growth:

Data in Table (1) show that plants irrigated with primary treated and chlorinated sanitary water (P.T.C.S.W.) gave higher number of leaves/plant and aerial parts fresh and dry weights than control plants with significant differences in the two seasons. The means of other growth traits under such treatment, however, were in the same rank of those gained by control plants, as the values obtained by these two treatments were close together with non-significant differences in all cases of both seasons. On the other hand, using non-chlorinated sanitary water significantly reduced all vegetative growth parameters scoring the least means in the two seasons.

Improving some characters of vegetative growth due to irrigation with chlorinated sanitary effluent might be interpreted according to the direct role of such water in increasing soil fertility by adding some nutrients and organic matter, which to somewhat, improve soil texture and structure (Hunshal *et al*., 2000). However, growth reduction occurred by using non-chlorinated sanitary water may be referred to accumulation of some toxic metals, which may cause chlorosis, growth depression and some physiological disorders (Nirit *et al*., 2006), or may due to contamination with some pathogens and parasites that cause some diseases affecting growth (Norman *et al*., 2003). Such results are coincidenced with those attained by Wu *et al*. (1995) on Hydrangea, Rosa, Jasminum and Azalea, Pinamonti *et al*. (1997) on Gerbera and Nirit *et al*. (2006) on roses.

2. Effect on flowering:

From data presented in Table (2), it is clear that both chlorinated and non-chlorinated sanitary water induced a significant precocity in flowering of bird-of-paradise plants by reducing the number of days form planting to first flower opening to 98.25 and 100.00 days against 105.50 days for control plants in the first season, and to 101.90 and 105.00 days against 110.78 days for control in the second one, respectively. Hence, the earliest flowering was observed due to chlorinated sanitary water treatment. This may be due to the presence of some nutrients and chemical compounds in such effluent necessary for accelerating flower bud development and opening. In this regard, Shore *et al*. (1995) suggested that alfalfa irrigated with sewage water may have levels of coumestrol (more than 30 microgram/g) which could affect cattle fertility, and that the agents in sewage water responsible for the increased phytoestrogen content of alfalfa are probably the steroidal estrogens, estrodiol and estrone, which are present in sewage water in concentrations ranging from 10 to 300 mg/l.

Such treatment (P.T.C.S.W.) resulted also the highest number of flowers/inflorescence and the longest vase-life with significant differences when compared to non-chlorinated and fresh water treatments. On the other hand, it significantly declined peduncle length in the two seasons. The least records in both seasons, however, were found due to irrigation with non-chlorinated sanitary water. This may refer to the presence of some pahtogenics in such polluted water (as shown in Table, c) which feed on the ripe sap of the plant. On the same line, those findings were indicated by Wallace *et al*. (1979) on chrysanthemum, Atzmon *et al*. (1997) on *Bougainvillea glabra* and Nancy-Ebner *et al*. (1999) on *Minneola tangelo* and carnation.

3. Effect on clumps productivity:

As shown in Table (3), non significant decrement was observed in number of rhizomes/clump due to irrigation with chlorinated sanitary water compared to control plants in the first season, while in the second one, the decrement was significant. The opposite was the right concerning fresh and dry weights of clump, as chlorinated water treatment significantly increased them comparing with those of control plants in both seasons. On the other hand, using non-chlorinated sanitary water gave, in general the least averages of the different clump measurements with significant differences when compared to either fresh or chlorinated water in the two seasons.

Table (3): Effect of irrigation with different water quantities on clumps productivity of *Strelitzia reginae* Ait. plants during 2005 and 2006 seasons

Water quality	First season 2005			Second season 2006		
	No. rhizomes per clump	Clump fresh weight (g)	Clump dry weight (g)	No. rhizomes per clump	Clump fresh weight (g)	Clump dry weight (g)
Fresh water	17.00 a	236.60 b	45.83 b	20.00 a	278.35 b	53.97 b
P.T.S.W.	14.00 b	204.75 c	39.96 c	16.00 c	234.28 c	45.73 c
P.T.C.S.W.	16.33 ab	285.74 a	55.31 a	18.76 b	327.41 a	63.15 a

*** P.T.S.W.: Primary treated sanitary water**
*** P.T.C.S.W.: Primary treated and chlorinated sanitary water**
*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level**

These results may indicate the role of chlorinated sanitary effluent on supplying the new formed rhizomes with the required nutrients necessary for accelerating growth, and on raising carbohydrates synthesis which accumulate in the rhizomes. In this regard, Gogate *et al*. (1995) mentioned that using sewage water to irrigate *Tectona grandis* trees reduced the cost of plantation by saving expenditure on manuring. Similarly, Wallace *et al*. (1979) reported that sewage water was a satisfactory source of nutrients for chrysanthemum culture without necessary use of manufactured fertilizers.

4. Effect on chemical composition:

It is obvious from data recorded in Table (4) that chlorophylls a, b and carotenoids content (mg/g fresh weight) in the leaves, as well as, total carbohydrates (mg/g dry weight), the percentages of N, P and K and the content of Pb and Cd as ppm in the leaves and rhizomes were increased as a result of irrigation with either of sanitary water used in the study with the excellence of chlorinated water treatment, which gave the utmost higher means for these constituents, with the exception of total carbohydrates and N content in the leaves, as well as, Pb and Cd content in the leaves and rhizomes that were slightly less than those registered by plants irrigated with non-chlorinated water. However, accumulation of total carbohydrates, K, Pb and Cd in the rhizomes was clearly higher than that in the leaves, but the opposite was the right regarding the percentages of N and P.

Increasing concentrations of Pb and Cd in the leaves and rhizomes did not lead to any morpho-or physio-logical disorders in plants because the concentrations of these tow metals did not reach toxic levels, which were 35-40 and 30-35 ppm for both respectively as mentioned by Macnicol and Beckett (1985). In this concern, Pinamonti *et al*. (1997) revealed that the use of sewage sludge compost did not lead to dangerous increases in the content of heavy metals (Zn, Cu, Ni, Pb, Cd and Cr) in the leaves of *Gerbera jamesonii* plants. Increasing chemical constituents in plant tissues may refer to the higher content of suspended solids, solutes and total N in the used sanitary water (Hunshal *et al*., 2000).

5. Effect on number of pathogenic indicators, salmonella & shigella and human parasites in plant, cut-flowers and soil:

According to data presented in Table (5), it could be concluded that bird-of-paradise plants and their cut- flowers, as well as, the soil were completely free from any pathogens of parasites when irrigated with either fresh or chlorinated sanitary water. Total and fecal coliform bacteria, however were detected in great numbers in plants and soil irrigated with non-chlorinated sewage effluent, but they were found in little numbers on the peduncle of the produced inflorescences. This may be due to the direct contact between irrigation water and the peduncles. Salmonella & shigella only infested the plants (in little numbers) and the soil (in great numbers), but did not appear on the peduncles. As for human parasites, some of them (such as *Emobiae histylotica* and ascaris ova) were detected only in the soil watered with non-chlorinated sewage effluent.

The aforementioned results may indicate the importance of chlorination treatment in sterilization of the sanitary water, and in getting rid of all harmful pathogens and parasites that may cause hazards for human, animal and environment. Such gains are in conformity with those of Vasseur *et al*. (1996) on conifers, Shahin *et al*. (2002) on ryegrass, Shahin and Boraas (2005) on *Dodonaea viscosa* and Hassan *et al.* (2006) who stated that the counts of the pollution indicator bacteria in the waste water used for irrigation of Taxodium, Albizzia and tipu trees were $7x10^5$, $6x10^6$ and $5x10^3$ cfu/100 ml for coliforms, *E. coli* and *Faecal streptococci*, respectively. Such numbers were greatly decreased in the soil exposed to sunlight and with time (after irrigation by about 2 weeks).

Table (5): Number of some pathogenic indicators, Salmonella & Shigella and parasites in *Strelitzia reginae* Ait. plants, cut-flowers and the used soil as affected by water quality at the end of the second season (2006)

Sample	Water quality	Pathogenic indicators (cfu/g)		Salmonella & Shigella (cfu/g)	Detection of parasites
		Total coliform bacteria	Fecal coliform bacteria		
Plant	Fresh water	n. d.	n. d.	n. d.	n. d.
	P.T.S.W.	6×10^3	7×10^2	1×10^2	n. d.
	P.T.C.S.W.	n. d.	n. d.	n. d.	n. d.
Cut-flower	Fresh water	n. d.	n. d.	n. d.	n. d.
	P.T.S.W.	8 x 10	1 x 10	n. d.	n. d.
	P.T.C.S.W	n. d.	n. d.	n. d.	n. d.
Soil	Fresh water	n. d.	n. d.	n. d.	n. d.
	P.T.S.W.	19×10^3	8×10^3	13×10^2	*E. histylotica &* ascaris ova
	P.T.C.S.W	n. d.	n. d.	n. d.	n. d.

*** P.T.S.W.: Primary treated sanitary water**
*** P.T.C.S.W.: Primary treated and chlorinated sanitary water**
*** cfu: Colony form unit   * E.: Emobiae   * n. d.: not detected**

B. Effect of water quality on vegetative growth, flowering, chemical composition and pathological analysis of *Dianthus caryophyllus* L. plant:

1. Effect of vegetative growth:

Data averaged in Table (6) exhibit that chlorinated sanitary water treatment induced a significant increment in the length of internode (cm) and top growth and roots dry weight (g), but induced a significant decrement in stem diameter (mm), number of internodes/stem, number of leaf pairs/ stem and top growth fresh weight (g) in the two seasons. However, the values of stem length (cm), leaf length (cm) and roots fresh weight (g) due to this treatment were in the same rank of control plants with non significant differences in both seasons. On the other hand, the least records in all previous traits were gained in the two seasons when the plants were watered with non-chlorinated sanitary effluent.

These results may be discussed as those attained in case of bird-of-paradise plant as mentioned before.

2. Effect on flowering:

As shown in Table (7), it is obvious that both chlorinated and non-chlorinated sewage water significantly accelerated flowering of treated plants by about 9 days in the first season and 10-12 days in the second one. They also raised the means of flower diameter (cm), No. petals/flower, No. flowers/ plant, flower fresh and dry weights (g), as well as, vase-life (days) with the superiority of chlorinated water treatment, which gave the highest records in most cases of both seasons. Stalk length (cm) is the only character, which was declined in the plants irrigated with non-chlorinated water in the two seasons. This may be due to decreasing of the internodes number in plants subjected to such treatment.

However, such gains could be interpreted and discussed as previously stated in case of bird-of-paradise plant.

3. Effect on chemical composition:

Data in Table (8) indicate that the contents of chlorophylls a, b and carotenoids (mg/g fresh weight), total carbohydrates (mg/g dry weight), the percentages of N, P and K, as well as, Pb and Cd content (ppm) were markedly elevated in the leaves of plants irrigated with either chlorinated or non-chlorinated sanitary water. The excellence was for chlorinated water treatment, which scored the highest concentrations in all previous constituents except for N% and the content of Pb and Cd (ppm) that were higher when non-chlorinated water was employed for irrigation.

These results could be explained and discussed as done before in case of bird-of-paradise plant.

Table (8): Effect of irrigation with different water qualities on chemical composition of *Dianthus caryophyllus* L., cv. Gigi herb during 2006 season

Water quality	Pigments content (mg/g fresh weight)			Total carbohydrates (mg/g dry weight)	N (%)	P (%)	K (%)	Pb (ppm)	Cd (ppm)
	Chl. a	Chl. b	Total Car.						
Fresh water	0.634	0.403	0.560	24.36	1.17	0.35	1.07	0.36	nil
P.T.S.W.	0.667	0.426	0.589	31.43	1.63	0.38	1.16	14.58	6.43
P.T.C.S.W.	0.719	0.463	0.636	36.79	1.58	0.44	1.30	13.09	5.87

*** P.T.S.W.: Primary treated sanitary water**

*** P.T.C.S.W.: Primary treated and chlorinated sanitary water**

4. Effect on number of pathogenic indicators, Salmonella & Shigella and human parasites in plant, cut flowers and soil:

Similar to those results of bird-of-paradise plant, data in Table (9) exhibit that both total and fecal coliform bacteria were only detected in carnation plants and soil irrigated with non-chlorinated sanitary water. The counts of total coliform bacteria in plant or soil were higher than those of fecal ones, but they were not almost detected in cut-flowers of carnation due to the farthest distance between irrigation water and flower stalks. Some human parasites (such as *Emobiae histylotica* and ascaris ova) infested only the soil watered with non-chlorinated sewage effluent.

However, such findings may be discussed as mentioned before in case of bird-of-paradise plant.

According to the whole previous results, it could be concluded that usage of primary treated sanitary water for production of bird-of-paradise and carnation cut-flowers is possible and may share in exploitation of such water and its disposal in a safe manner proved to be chlorinated with 2.5 g Cl/m^3 of water flow.

Table (9): Number of some pathogenic indicators, Salmonella and Shigella and parasites in *Dianthus caryophyllus* L., cv. Gigi plants, cut-flowers and the used soil as affected by water quality at the end of the second season (2006)

Sample	Water quality	Pathogenic indicators (cfu/g)		Salmonella & Shigella (cfu/g)	Detection of parasites
		Total coliform bacteria	Fecal coliform bacteria		
Plant	Fresh water	n. d.	n. d.	n. d.	n. d.
	P.T.S.W.	4×10^2	2×10^2	n. d.	n. d.
	P.T.C.S.W.	n. d.	n. d.	n. d.	n. d.
Cut-flower	Fresh water	n. d.	n. d.	n. d.	n. d.
	P.T.S.W.	n. d.	n. d.	n. d.	n. d.
	P.T.C.S.W	n. d.	n. d.	n. d.	n. d.
Soil	Fresh water	n. d.	n. d.	n. d.	n. d.
	P.T.S.W.	15×10^2	1×10^3	3×10^2	*E. histylotica* & ascaris ova
	P.T.C.S.W	n. d.	n. d.	n. d.	n. d.

*** P.T.S.W.: Primary treated sanitary water**
*** P.T.C.S.W.: Primary treated and chlorinated sanitary water**
*** cfu: Colony form unit** *** E.: Emobiae** *** n. d.: not detected**

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استخدام مياه الصرف الصحى لإنتاج بعض زهور القطف

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أجريت تجربتا اصص بمحطة تجارب قسم الخضر والزينة، كلية الزراعة جامعة المنصورة خلال موسمى 2005، 2006 وذلك لدراسة تأثير الرى بمياه الصرف الصحى المعالجة أوليا (المكلورة والغير مكلورة) على النمو، الإزهار والتركيب الكيمائى لنباتى عصفور الجنة (*Strelitzia reginae* Ait.) والقرنفل (*Dianthus caryophyllus* L.) صنف Gigi النامية فى تربة طينية تحت ظروف الشمس الساطعة، وكذلك لتقييم حجم التلوث الذى قد ينشأ عن وجود بعض الطفيليات والمسببات المرضية الموجودة فى المياه المستخدمة ومدى تواجدها على النبات، زهور القطف الناتجة وفى التربة بعد الرى بهذه النوعية من المياه، كأحد المؤشرات المحددة لصلاحية إستخدام هذه المياه فى الإنتاج الآمن لهذه الزهور.

ولقد أوضحت النتائج المتحصل عليها أن إستخدام مياه الصرف الصحى المكلورة فى رى كل من نباتات عصفور الجنة والقرنفل قد أحدثت زيادة معنوية فى بعض صفات النمو الخضرى لكلا النباتين، وكذلك الوزن الطازج والجاف للكتلة الريزومية لنباتات عضفور الجنة، والوزن الجاف فقط لجذور القرنفل. كما أدت إلى حدوث أكبر تبكير فى إزهار كلا النباتين والذى كان مصحوبا بتحسن فى بعض صفات الجودة للأزهار الناتجة وزيادة فى عمر الأزهار بالفازة. علاوة على ذلك فقد تحسن محتوى أوراق كلا النباتين وريزومات عصفور الجنة من المكونات الكيمائية، التى زادت معظمها معنويا بإستثناء بعض المكونات. أيضا لم تظهر أية أنواع من البكتريا الممرضة أو السالمونيللا والشيجيللا أو الطفيليات الأدمية بالنباتات وزهور القطف الناتجة والتربة التى رويت بمياه الصرف المكلورة. على الجانب الآخر، فإن أقل متوسطات لجميع قياسات النمو الخضرى والزهرى والتركيب الكيمائى قد سجلت بواسطة النباتات التى رويت بمياه الصرف الصحى الغير مكلورة، والتى أدت أيضا إلى تلوث النباتات وزهور القطف الناتجة من نباتات عصفور الجنة وكذلك التربة بالعديد من الطفيليات والبكتريا الممرضة.

وعليه، فإنه لكى نستثمر مياه الصرف الصحى المعالجة أوليا فى الإنتاج الآمن لزهور القطف من نباتات عصفور الجنة والقرنفل، فإنه لابد من كلورة هذه المياه قبل إستخدامها بمعدل 2 جم كلورين / م^3 من مياه الصرف المتدفقة.

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Table (a): Some physical and chemical properties of the used soil in 2005 and 2006 seasons

Season	Soil properties														
	Particles size distribution (%)				SP (%)	pH	EC (dS/m)	Cations (meq/L)				Anions (meq/L)			SAR
	C. sand	F. sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO^{-}_{3}	Cl^{-}	$SO^{-}_{4}{}^{-}$	
2005	7.54	22.28	30.55	39.63	50.00	8.35	2.29	7.82	2.12	15.40	0.75	6.60	8.20	11.29	7.02
2006	7.64	22.50	30.15	39.71	50.00	8.12	2.38	7.50	2.20	15.50	0.75	6.78	8.02	11.15	7.00

*** EC and soluble ions were determined in the soil paste extract**
*** SAR : Sodium adsorption ratio**

Table (b): Chemical characteristics of the used sanitary water samples during 2005 and 2006 seasons

Season	Sanitary water used	EC (dS/m)	pH	Cations (meq/L)				Anions (meq/L)			Heavy metals content (ppm)						
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO^{-}_{3}	Cl^{-}	$SO^{-}_{4}{}^{-}$	Fe	Zn	Mn	Cu	Co	Cd	Pb
2005	P.T.S.W.	1.34	7.5	1.62	4.16	0.89	7.33	6.82	3.76	3.42	1.08	0.49	0.07	1.05	0.003	0.003	0.12
2006	P.T.C.S.W.	1.52	7.5	1.96	3.67	1.00	9.57	7.00	5.50	3.70	0.94	0.56	0.05	1.00	0.002	0.002	0.13

*** P.T.S.W.: Primary treated sanitary water**
*** P.T.C.S.W.: Primary treated and chlorinated sanitary water**

Table (1): Effect of irrigation with different water qualities on some vegetative growth parameters of *Strelitzia reginae* Ait. plants during 2005 and 2006 seasons

Water quality	Plant height (cm)	Leaf No./ plant	Petiole length (cm)	Petiole diameter at the base (cm)	Lamina length (cm)	Lamina width (cm)	Aerial parts fresh weight (g)	Aerial parts dry weight (g)
	First season 2005							
Fresh water	124.00 a	16.00 b	77.38 a	1.60 a	41.50 a	9.63 ab	761.45 b	174.37 c
P.T.S.W.	102.75 b	14.00 c	66.41 b	1.23 b	30.00 b	9.25 b	754. 67 c	199.20 b
P.T.C.S.W.	121.76 ab	18.00 a	76.50 a	1.68 a	40. 86 a	9.76 a	778.53 a	205.34 a
	Second season 2006							
Fresh water	130.16 a	16.00 b	81.00 a	1.68 a	42.76 a	9.51 ba	793.80 b	181.69 c
P.T.S.W.	109.33 b	16.00 b	72.50 b	1.32 b	33.28 b	9.30 b	788.67 c	207.73 b
P.T.C.S.W.	128.56 a	18.00 a	80.23 a	1.70 a	41.93 a	9.82 a	801.37 a	211. 38 a

*** P.T.S.W.: Primary treated sanitary water** *** P.T.C.S.W.: Primary treated and chlorinated sanitary water**

*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level**

Table (2): Effect of irrigation with different water qualities on some flowering parameters of *Strelitzia reginae* Ait. plants during 2005 and 2006 seasons

Water quality	No. days to 1st flower opening (day)	Peduncle length (cm)	Peduncle diameter at the base (cm)	No. flowers/ inflorescence	No. inflorescences/ plant	Vase life (days)
	First season 2005					
Fresh water	105.50 a	46.00 a	1.15 a	2.00 b	3.00 a	7.50 b
P.T.S.W.	100.00 b	35.07 c	1.01 b	2.00 b	2.00 b	7.75 b
P.T.C.S.W.	98.25 c	42.16 b	1.12 a	3.00 a	2.67 ab	9.50 a
	Second season 2006					
Fresh water	110.78 a	48.27 a	1.21 a	2.00 b	3.00 a	8.00 b
P.T.S.W.	105.00 b	36.76 c	1.06 b	1.86 b	2.00 b	8.19 b
P.T.C.S.W.	101.90 c	44.38 b	1.18 a	3.00 a	3.00 a	9.98 a

*** P.T.S.W.: Primary treated sanitary water** *** P.T.C.S.W.: Primary treated and chlorinated sanitary water**

*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level**

Table (4): Effect of irrigation with different water qualities on chemical composition of *Strelitzia reginae* Ait. leaves and rhizomes during 2006 season

Water quality	Pigments content (mg/g fresh weight)			Total carbohydrates (mg/g dry weight)		N (%)		P (%)		K (%)		Pb (ppm)		Cd (ppm)	
	Chl. a	Chl. b	Total Car.	Leaves	Rhizome	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.
Fresh water	1.493	0.538	0.987	23.35	27.96	1.76	1.23	0.63	0.49	1.18	1.37	0.41	0.64	nil	nil
P.T.S.W.	1.612	0.581	1.046	25.47	30.38	1.87	1.33	0.71	0.56	1.30	1.46	10.81	17.93	2.43	8.33
P.T.C.S.W.	1.756	0.672	1.151	25.23	35.27	2.26	1.32	0.75	0.67	1.51	1.59	9.68	17.01	2.19	8.19

*** P.T.S.W.: Primary treated sanitary water** *** P.T.C.S.W.: Primary treated and chlorinated sanitary water**
*** L.: Leaves** *** R.: Rhizomes**

Table (6): Effect of irrigation with different water qualities on some vegetative and root growth parameters of *Dianthus caryophyllus* L., cv. Gigi plants during 2005 and 2006 seasons

Water quality	Stem length (cm)	Stem diameter (mm)	No. internodes per stem	Internodes length (cm)	No. leaf pairs per stem	Leaf length (cm)	Top growth fresh weight (g)	Top growth dry weight (g)	Roots fresh weight (g)	Roots dry weight (g)
	First season 2005									
Fresh water	82.50 a	4.28 a	20.33 a	4.06 b	19.33 a	10.28 a	52.56 a	15.37 b	5.18 a	2.53 ba
P.T.S.W.	77.00 b	3.30 c	17.76 b	4.34 ab	16.67 b	8.79 b	46.20 c	18.46 ab	4.80 b	2.50 b
P.T.C.S.W.	81.36 a	3.79 b	18.00 b	4.52 a	17.00 b	9.67 ab	48.33.b	18.97 a	4.96 ba	2.61 a
	Second season 2006									
Fresh water	90.16 a	4.52 a	21.56 a	4.18 b	20.88 a	10.30 a	55.12 a	16.18 b	5.48 a	2.68 b
P.T.S.W.	85.43 b	3.57 c	19.10 b	4.47 a	18.00 b	9.22 b	48.98 c	19.51 ab	5.08 b	2.66 b
P.T.C.S.W.	89.10 a	4.01 b	19.45 b	4.58 a	18.41 b	10.26 a	52.29 b	20.07 a	5.26 b	2.81 a

*** P.T.S.W.: Primary treated sanitary water** *** P.T.C.S.W.: Primary treated and chlorinated sanitary water**
*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level**

Table (7): Effect of irrigation with different water qualities on flowering of *Dianthus caryophyllus* L., cv. Gigi plants during 2005 and 2006 seasons

Water quality	No. days to 1st flower opening (day)	flower diameter (cm)	No. petals per flower	Stalk length (cm)	No. flower per plant	Flower fresh weight (g)	Flower dry weight (g)	Vase life (days)
	First season 2005							
Fresh water	102.33 a	7.90 b	54.33 b	66.18 a	2.00 b	8.70 b	3.05 c	7.50 b
P.T.S.W.	93.00 b	8.87 a	58.00 a	59.72 b	3.00 a	9.46 ba	3.36 b	8.00 b
P.T.C.S.W.	93.37 b	8.93 a	58.00 a	63.28 a	3.00 a	9.80 a	3.97 a	10.33 a
	Second season 2006							
Fresh water	104.26 a	8.07 b	55.76 b	71.78 a	2.00 b	8.53 b	3.16 c	8.16 b
P.T.S.W.	94.50 b	8.96 a	60.00 a	67.50 b	3.00 a	9.87 ab	3.48 b	8.43 b
P.T.C.S.W.	92.67 b	9.03 a	60.00 a	70.76 a	3.00 a	10.09 a	4.10 a	10.00 a

*** P.T.S.W.: Primary treated sanitary water** *** P.T.C.S.W.: Primary treated and chlorinated sanitary water**
*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level**