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ORIGINAL ARTICLE

Responses of growth of lady's fingers (*Abelmoschus esculentus* L.) to different treatments methods of dairy wastewater

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Abstract
Introduction and objective. Water is one of the most important precious resources found on the earth, and are most often affected by anthropogenic activities and by industry. Pollution caused by human beings and industries is a serious concern throughout the world. Population growth, massive urbanization, rapid rate of industrialization and modern techniques in agriculture have accelerated water pollution and led to the gradual deterioration of its quality. A large quantity of waste water disposed of at sea or on land has caused environmental problems which have led to environmental pollution, economic losses and chemical risks caused by the wastewater, and its impact on agriculture. However, waste water which contain nutrients and organic matter has possible advantages for agricultural purposes. Therefore, the presented study was undertaken to assess the impact of Dairy Effluent (treated and untreated waste water) on seed germination, seedling growth, dry matter production and the biochemical parameters of lady's fingers (*Abelmoschus esculentus* L.).
Materials and methods. A field experiment in a green house was conducted to use raw and treated dairy wastewater for watering lady's fingers (*Abelmoschus esculentus* L.). The plants were watered using (WW) raw dairy wastewater, (T1) chemicals treatment, (T2) physical treatment, (T3) dilution method treatment and tap water (TW) in pot experiments. Ten plants of each treatment /3 replicate were randomly selected and labelled for the collection of data. The data was collected sequentially, starting with chlorophyll content pre-harvest, vegetative qualities (shoot, root and seedling length) and dry matter quality (shoot and root dry matter) pos-tharvest.
Results. The effect was seen on the germination seed and growth of the plant. The results showed inhibitory effect from dairy effluent (WW) on seed germination and plant growth. Treatment with chemicals showed statistically significant differences with other treatments. Chemical treatment (TC2) at 20 mg/L $Al_2(SO_4)_3$ and pH 6.5 improved all growth characteristics, compared with WW, and TW reached 85%, 70.8 cm, 28.6 cm, 99.4 cm, 65.36%, 15.86% and 3.543 Mg\g FW for seed germination, shoot length, root length, seedling length, shoot dry matter, root dry matter and chlorophyll, respectively. Also, 25% concentration and 6.5 pH from the dilution method treatment improved all the qualities, but at a lower level. A maximum favourable effect was also observed in the (T2) physical treatment, and ranged from average to moderate in terms of impact.
Conclusions. Thus, dairy effluent, after chemical treatment and proper dilution, can be used as a potential source of water for seed germination and plant growth in agricultural practices.

Key words
Environmental pollution, wastewater treatment, irrigation, agricultural purposes

INTRODUCTION

Water is one of the most important precious resources found on earth, and is the resource most often affected by anthropogenic activities and by industry. Pollution caused by human beings and industry is a serious concern throughout the world. Population growth, massive urbanization, rapid rate of industrialization and modern techniques in agriculture have accelerated water pollution and led to the gradual deterioration of its quality [1, 2]. Due to the continuous disposal of wastewater into bodies of water, the quality of surface water throughout the country – Malaysia in the presented study – has deteriorated because of the mixing of various chemical pollutants of effluent with the water [3]. The surface water quality has declined to such a level that soon it will not be useful for any purpose. The use of industrial liquid effluent for agricultural irrigation has been in vogue in many countries worldwide. This effluent contains various micro-nutrients essential for the growth of crop plants. However, many industrial wastes may have harmful effects and may cause soil fatigue [4].

The dairy industry is one of the most important agro-based industries in Malaysia and produces huge amounts of effluents through its processing units. The clean water is used in various stages of dairy operations, such as milk processing, cleaning, packaging and cleaning of the milk tankers, and releases the wastewater which is known as dairy effluent. The water is used for processing in the ratio of 1:10 (water: milk) [5] per liter of milk. The water resources are most often affected by industrial pollution, caused by industrial and dairy effluents, and is a serious concern throughout the world. Dairy effluent has high organic loads as milk is its basic constituent with high levels of chemical oxygen demand, biological oxygen demand, and nitrogen and phosphorous content. The recycling of nutrients through the land application of dairy waste effluent requires the use of crops capable of utilizing these nutrients [6]. Industrial effluents rich in organic matter and plant

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nutrients are finding agricultural use as a cheaper way of their disposal.

However, before any specific wastewater can be used for the irrigation of a particular crop, a detailed scientific study and the environmental conditions need investigating because different crop species may have different tolerances to various pollutants. Seed germination and plant growth bioassays are the most common techniques used to evaluate phytotoxicity [7]. Also, because of the high cost and scarcity of chemical fertilizers, the land disposal of agricultural, municipal and industrial waste is widely practiced as a major and economic source of nutrients and organic matter for growing cereal crops [8, 9]. The use of such waste water in an irrigation system definitely provides some nutrients, not only to enhance the fertility of soil, but also to deposit toxicants that change soil properties in the long-term. The presented study was designed for screening the suitability of dairy effluent treatment for use in irrigation. The crop selected for this purpose was lady's fingers (*Abelmoschus esculentus* L.).

MATERIALS AND METHOD

Experimental procedure. The study was conducted in a green house at the School of Biological Science of Universiti Sains Malaysia (USM), Penang, Malaysia, between March -June 2012 to study the effect of wastewater (Dairy Effluent) on the seed germination and growth of lady's fingers (*Abelmoschus esculentus* L.). Maximum temperature during the study period varied between 28 – 32^{o}C.

Sampling of raw dairy wastewater (WW). The dairy effluent samples were collected in dry plastic containers which were rinsed with HNO_3 and distilled water, and then in effluent from a dairy factory in the industrial area of Bayan Lepas, Pulau Pinang, Malaysia. The combined samples of effluent were collected at the main drain pipe which connects a washing tank to the outside discharge unit.

Characterization of dairy effluent. The physico-chemical properties of dairy effluent samples were analyzed according to standard procedures [2]. Results given in Table 1. The dairy effluent samples were treated by using different ameliorative techniques, physical treatment, chemical coagulation, and flocculation and dilution method using different concentrations (**Tab. 1**). The treated samples were used independently to assess their effects on seed germination and other growth parameters of lady's fingers (*Abelmoschus esculentus* L.) in the green house.

TREATED DAIRY WASTEWATER BY DIFFERENT TREATMENT APPROACH

Chemicals treatment (T1). The coagulation and flocculation process through Jar test (using a beaker) was used to determined the best dose of Aluminum sulfate $Al_2(SO_4)_3$ and anionic polymer. The dose of selected coagulant (Alum) to each beaker (15 and 20 mg/L) and 5 mg\L Anionic polymers was added to each of six beakers during the chemical treatment test.

Physical treatment (T2). Filtered raw waste water was obtained by filtering the raw wastewater through 1µm and 5µm membrane filters. The samples were collected and kept in sterile containers until use.

Dilution method (T3). Dilution of dairy wastewater was carried out by mixing a wastewater sample with tap water as per the following description. The ratio of 1 (wastewater):3 (tap water) represents the concentrations of 25%, and the ratio of 1 (wastewater:1 (tap water) gives a concentration of 50% of diluted samples, respectively. The diluted samples were thoroughly stirred and the pH adjusted prior to use in the plant irrigation.

pH. The studied pH was selected based on the suitability of the pH for the plant to grow is from the range of 5.5 – 7.5. The samples were agitated for 5 min and pH adjustment (5.5, 6.5 and 7.5) of the wastewater sample carried out by using a pH meter. Samples with adjusted pH were used for each treatment (chemical, physical and dilution).

Dairy wastewater characterization. Wastewater samples were collected at different times in order to characterize the wastewater quality for irrigation purposes. The concentration of nutrients (N, P, and K) and metals were determined by an Atomic Absorption Spectrometer (AAS). The physicochemical parameter was also determined. Soil samples were collected at each site, composite surface soil (0–10 cm depth) samples (from a field of the biological school, USM) and planting pot filled with about 1kg of soil. These samples were analyzed for different properties using a standard method [2].

Experiment design. The treated samples were used independently to assess their effects on seed germination and growth parameters in the green house. Lady's fingers seeds were obtained directly from a local market (Tesco Extra) with 0.1 percent mercuric chloride (HgC_{12}) and washed with distilled water [10]. Twenty seeds were placed equi-distant from one another in germination towels, which were soaked in different concentrations of effluents, treated effluents and tap water. The germination towels were watered uniformly with different concentrations of effluent and treated effluents. The number of seed germinations was counted on day 10 and the total germination percentage calculated. Data were taken from three replicates of the 10-day-old seedlings.

Plastic pots, 15 cm diameter × 14 cm height, were filled with equal amounts (1 kg) of sandy loam soil of medium fertility, and the 5 seeds pioneer cultivar of lady's fingers (*Abelmoschus esculentus* L.) were sown in each pot. 100 ml of differently treated effluents were used for the manual irrigation of the selected pots. Samples of treated water were prepare directly before watering. The experiment was applied for 3 months under green house conditions with regular irrigation length of growth. Three replicates were applied for each treatment twice, the plants harvested after 3 months and data collected.

Parameters studies. Ten plants of each treatment in 3 replicates were randomly selected and labeled for data collection. The data was collected sequentially, starting with chlorophyll content pre-harvest, vegetative qualities (shoot, root and seedling length), and dry matter qualitative (Shoot and root dry matter) post-harvest.

Germination test (%). The germination test was conducted using the paper towel method as prescribed in ISTA rules

[11], by providing the optimum conditions for each test of the crop. The daily germination counts were made on normal seedlings and total germination calculated and expressed as a percentage:

$$*GT = [N_T \times 100] \backslash N$$

*Where:
N_T= Number of seedlings emerging on the day and N= Day after planting.

Chlorophyll content. mg\g FW (Fresh Weight). Chlorophyll content was estimated by extracting fresh leaves with 80% acetone, and after centrifugation at 8,000 rpm for 20min, measuring the colour intensity of the extract at (645 and 663) nm wave lengths by spectrophotometer (Spectra scan UV 2700). The method of [11] was used to calculate the chlorophyll a and chlorophyll b contents:

$$*\text{Total chlorophyll} = \frac{20.2 \times D_{(645)} + 8.02 \times D_{(663)}}{(V/W \times 1000) \times 100}$$

*Where:
$D_{(663)}$ = Reading the optical absorption of wavelength 663 nm
$D_{(645)}$ = Reading the optical absorption of wavelength 645 nm
V= Volume 20 ml
W = weight 1 g

Vegetative qualities. The plants post-harvest after 2 hours of irrigation were washed to remove the dust and plankton vegetative qualities determination following the methods below:

Shoot length. The shoot length was measured at the area of contact between the stem and root; mean shoot length was expressed in centimeters using a measuring tape (cm).

Root length. Shoot length measurement was also used for the measurement of root length. This was measured from the tip of the primary root to the base; mean root length was expressed in centimeters using a measuring tape (cm).

Seedling lengths. By adding the shoot and root lengths of already selected normal seedlings the seedling length was calculated and expressed as mean seedling length in centimeters (cm) using a measuring tape (cm).

Dry matter qualitative. The plants used for measuring the vegetative qualities were kept in paper bags vinaigrette after separation of the shoots and roots. The sample was dried in an oven at 40 °C for 2 days. Dry matter qualitative determination was made following the methods below:

Shoot dry matter (%). Dried shoot weight was noted by using a normal balance and by the following formula [12] for final weight determination:

$$\text{Shoot Dry matter} = \text{Shoot dry weight/ fresh weight} \times 100.$$

Root dry matter (%). The root dry matter weight was determined through the formula below by Dalaly and Al-Hakim (1987):

$$\text{Root dry matter} = \text{Root dry weight} \backslash \text{ fresh weight} \times 100.$$

Statistical Analysis. The experimental data was subjected to analysis of variance (ANOVA). Significant differences between values were determined using Duncan's Multiple Range test ($P < 0.05$) following ANOVA. Statistical analyses were performed using SPSS (SPSS version 19, Chicago, USA, 2012).

RESULTS

Water characteristics. The physico-chemical properties of dairy effluent are given in Table 1. The effluent was milky white in colour, turbid with oil, and had a stringent, unpleasant smell. In general, the quality of all 3 treatments (T1, T2 and T3) came within permissible limits for irrigation water as per the Quality Standards Table (1), with Superiority significantly for chemical treatment on of the rest treatments (T1 and T2) except tap water (control) that was different than other treatments with respect to all measured parameters. Chemical treatment (T1) was better per all water properties, and showed significant reduction in TDS and BOD compared

Table 1. Physico-chemical properties of treated Dairy Effluent (WW)

Parameters	Unit	*Standard	Raw dairy w\w	Dilution		Physical treatment		Chemical treatment	
				25%	50%	**1μm	5μm	$Al_2(SO_4)_3$ 15 mg\L	$Al_2(SO_4)_3$ 20 mg\L
		Values							
pH		5–9	8.570	5.5–6.5–7.5	5.5–6.5–7.5	5.5–6.5–7.5	5.5–6.5–7.5	5.5–6.5–7.5	5.5–6.5–7.5
BOD	mg\L	12	213.490	43.000	100.000	140.000	145.000	20.000	15.000
COD	mg\L	100	505.000	121.000	200.000	470.000	491.000	80.000	71.000
TDS	mg\L	4000	715.760	203.000	400.000	710.000	713.000	307.000	256.000
TSS	mg\L	400	444.980	250.000	350.000	123.000	205.000	119.000	103.000
N	mg\L	25	7.800	2.632	3.213	7.100	7.534	2.978	1.231
P	mg\L	10	11.000	7.498	9.854	10.565	10.590	4.303	3.561
K	mg\L	20	20.000	7.981	11.701	19.122	19.402	6.530	4.602
Ca	mg\L	< 400	83.000	21.874	45.798	82.290	82.780	51.000	47.132
Mg	mg\L	< 60	30.000	9.4789	17.900	29.010	29.430	12.200	9.331
Cl	mg\L	< 350	48.000	29.712	30.000	48.000	48.000	35.000	35.000

*Standard [26, 27]
Note: ** membrane size

Table 2. Effect of wastewater chemically treated with $Al_2(SO_4)_3$ Mg/l at different pH on plant growth characteristics analyzed by average ANOVA

Treatments	Germination %	Seedling growth (cm)			Shoot dry matter (%)	Root dry matter (%)	Chlorophyll content. mg/g fw
		Shoot length	Root length	Seedling length			
TW [Tap water)	90.00 ^{a}	38.00 ^{i}	11.60 ^{e}	49.93 ^{i}	43.75 ^{h}	10.294 ^{e}	2.761 b^{c}
WW (raw)	30.00 ^{f}	23.30 ^{h}	7.30 ^{f}	30.60 ^{h}	29.14 ^{i}	6.190 ^{f}	1.109 ^{d}
TC1– $Al_2(SO4)_3$ 20 mg/ L – pH 5.5	80.00 ^{c}	60.50 ^{c}	21.70 ^{c}	82.20 ^{d}	60.80 ^{c}	12.40 ^{d}	2.949 ^{ab}
TC2 – $Al_2(SO4)_3$ 20 mg/ L – PH 6.5	85.00 ^{b}	70.80 ^{a}	28.60 ^{a}	99.40 ^{a}	65.36 ^{a}	15.86 ^{a}	3.543 ^{a}
TC3 – $Al_2(SO4)_3$ 20 mg/ L – pH 7.5	80.00 ^{c}	68.00 ^{b}	25.80 ^{b}	93.80 ^{b}	62.50 ^{b}	14.25 ^{b}	3.00 ^{ab}
TC4 – $Al_2(SO4)_3$ 15 mg/ L – pH 5.5	70.00 ^{e}	53.00 ^{f}	20.00 ^{d}	73.00 ^{f}	50.56 ^{f}	11.53 ^{e}	2.13 ^{c}
TC5 – $Al_2(SO4)_3$ 15 mg/ L – PH 6.5	75.00 ^{d}	58.30 ^{d}	25.50 ^{b}	83.80 ^{c}	55.76 ^{d}	14.566 ^{b}	2.598 ^{bc}
TC6 – $Al_2(SO4)_3$ 15 mg/ L – pH 7.5	70.00 ^{e}	55.00 ^{e}	21.50 ^{c}	76.50 ^{e}	52.23 ^{e}	12.796 ^{c}	2.254 ^{c}

* Similar characters in the same column indicate non-significant and different characters in the same column indicate non-significant (ANOVA P<0.05)

Table 3. Effect of wastewater physically treated (membrane size /mμ) at different pH on plant growth characteristic analyzed by average ANOVA

Treatments	Germination %	Seedling growth(cm)			Shoot dry matter (%)	Root dry matter (%)	Chlorophyll content. mg\g fw
		Shoot length	Root length	Seedling length			
TW Tap water (control)	90.00 ^{a}	38.0 ^{a}	11.60 ^{a}	49.60 ^{a}	43.75 ^{a}	10.29 ^{a}	2.76 ^{a}
WW Wastewater (crud)	30.00 ^{e}	23.30 ^{h}	6.30 ^{e}	29.60 ^{h}	29.14 ^{e}	6.19 ^{ed}	1.10 ^{i}
T2F1 1μm- pH 5.5	65.00 ^{c}	28.10 ^{d}	8.00 ^{dc}	36.10 ^{e}	32.00 ^{d}	6.85^{c}	1.36 ^{e}
T2F2 1μm- pH 6.5	70.00 ^{b}	31.50 ^{b}	9.23 ^{b}	40.73 ^{b}	35.12 ^{b}	8.00 ^{b}	1.85 ^{b}
T2F3 1μm- pH 7.5	65.00 ^{c}	29.73 ^{c}	8.73 ^{bc}	38.46 ^{c}	33.33 ^{c}	7.23 ^{c}	1.55 ^{c}
T2F4 5μm- pH 5.5	60.00 ^{b}	25.40 ^{f}	6.75 ^{e}	32.15 ^{f}	31.06 ^{d}	6.48 ^{d}	1.21 ^{h}
T2F5 5μm- pH 6.5	65.00 ^{c}	29.00 ^{c}	7.76 ^{d}	36.76 ^{e}	33.00 ^{c}	6.96 ^{c}	1.43 ^{d}
T 2 F6 5μm- pH 7.5	60.00 ^{b}	26.73 ^{e}	6.88 ^{e}	33.03 ^{f}	31.60 ^{d}	6.53 ^{c}	1.26 ^{f}

* Similar characters in the same column indicate non-significant and different characters in the same column indicate non-significant (ANOVA P<0.05).

Table 4. Effect of the use of dilution treatment (%) at different pH on plant growth characteristics analyzed by average ANOVA

Treatments	Germination %	Seedling growth(cm)			Shoot dry matter (%)	Root dry matter (%)	Chlorophyll content. mg\g fw
		Shoot length	Root length	Seedling length			
Tap water (control)	90.00 ^{a}	38.00 ^{f}	11.60 ^{f}	49.93 ^{f}	43.75 ^{e}	9.62 ^{e}	2.76 ^{c}
Wastewater (crud)	30.00 ^{f}	23.30 ^{h}	7.30 ^{h}	30.60 ^{h}	29.14 ^{h}	6.19 ^{g}	1.10 ^{f}
TCO1 – 25% – pH 5.5	80.00 ^{c}	48.50 ^{c}	14.20 ^{c}	62.70 ^{c}	50.11 ^{c}	11.36 ^{c}	2.96 ^{b}
TCO2 – 25% – pH 6.5	85.00 ^{b}	52.70 ^{a}	18.60 ^{a}	71.30 ^{a}	61.50 ^{a}	13.30 ^{a}	3.55 ^{a}
TCO3 – 25% – pH 7.5	80.00 ^{c}	50.50 ^{b}	16.30 ^{b}	67.46 ^{b}	54.62 ^{b}	12.34 ^{b}	3.09 ^{b}
TCO4 – 50% – pH 5.5	70.00 ^{e}	34.10 ^{g}	10.00 ^{g}	44.10 ^{g}	38.00 ^{g}	8.32 ^{f}	1.89 ^{e}
TCO5 – 50% – pH 6.5	75.00 ^{d}	42.50 ^{d}	14.10 ^{d}	56.60 ^{d}	47.80 ^{d}	10.76 ^{d}	2.75 ^{c}
TCO6 – 50% – pH 7.5	70.00 ^{e}	39.00 ^{e}	12.40 ^{e}	51.40 ^{e}	41.40 ^{f}	8.67 ^{f}	2.42 ^{d}

* Similar characters in the same column indicate non-significant and different characters in the same column show non-significant (ANOVA P<0.05)

with those untreated (Tab. 1). Also, on an average basis, there was an improvement in pH, while nutrient concentrations and heavy metals content were below the irrigation standards [3].

Effect of the chemical treatments (T1). The treated dairy effluent samples showed favourable effects on seed germination and other growth parameters of lady's fingers (*Abelmoschus esculentus* L.) compare with crude dairy effluent (untreated) and tap water. The result (**Tab. 1**) showed the presence of statistically significant differences in the percentage (%) of seed germinations, seedling growth (cm) and dry matter production, depending on the dose used and the pH value. The maximum promoting effect was recorded in the treatment [TC2 ($Al_2(SO_4)_3$ 20 mg/ L – PH 6.5)], which gave the highest averages for all characteristics under study. There then followed treatment [TC3 ($Al_2(SO_4)_3$ 20 mg/L – PH 7.5)] which improved plant growth generally. (**Tab. 1, Fig. 1, 2, 3, 4, 5, 6 and 7**). Other chemical treatments showed little statistical significance when compared with water, but outperformed the untreated raw water that showed an inhibitory effect on plant growth.

Physical treatments T2. The results showed statistically significant differences between treated wastewater water and untreated water (raw dairy wastewater) effect on the plant growth at green house. Table 3 and Fig. 1, 2, 3, 4, 5, 6 and 7 but did not reach to significant limits to compare with tap water, which outperform on all transactions.

All the treatments improved growth properties in the plants, compared with crude wastewater. The maximum promoting effect was recorded at control; also, a membrane of 1 μm / pH.6.5 (TF2) significantly outperformed all other

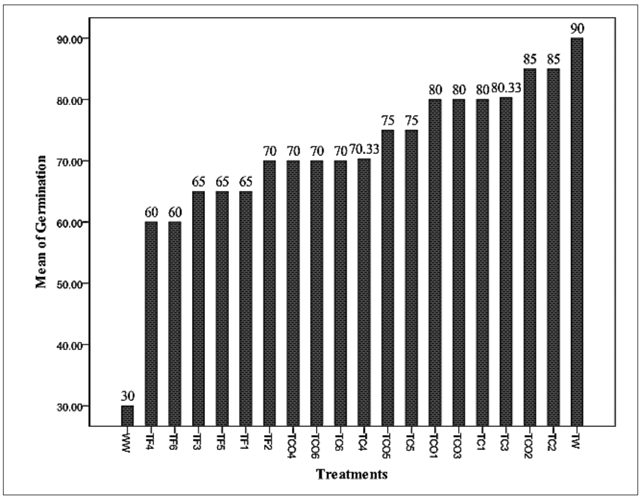

Figure 1. Effect of types of treatment (chemicals, concentrations and physicals) on germination (%) seeds lady's fingers *(Abelmoschus esculentus* L.)

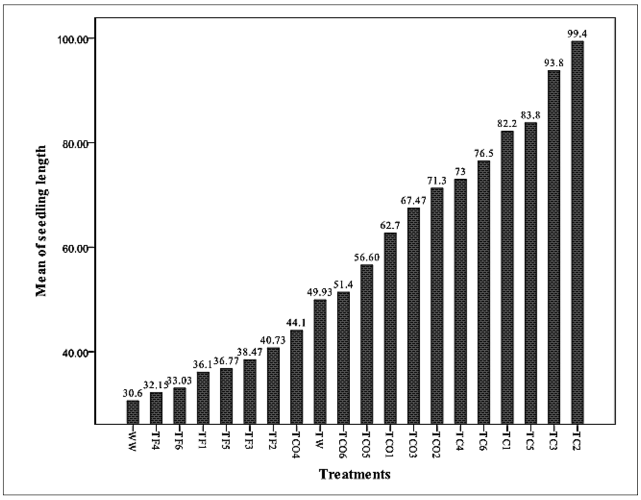

Figure 4. Effect of types of treatment (chemicals, concentrations and physicals) on seedling length (cm) seeds on lady's fingers (*Abelmoschus esculentus* L.)

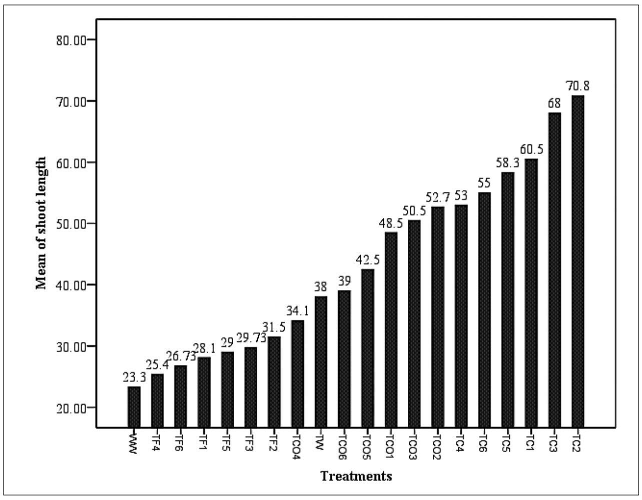

Figure 2. Effect of types of treatment (chemicals, concentrations and physicals) on shoot length (cm) seeds of lady's fingers (*Abelmoschus esculentus* L.)

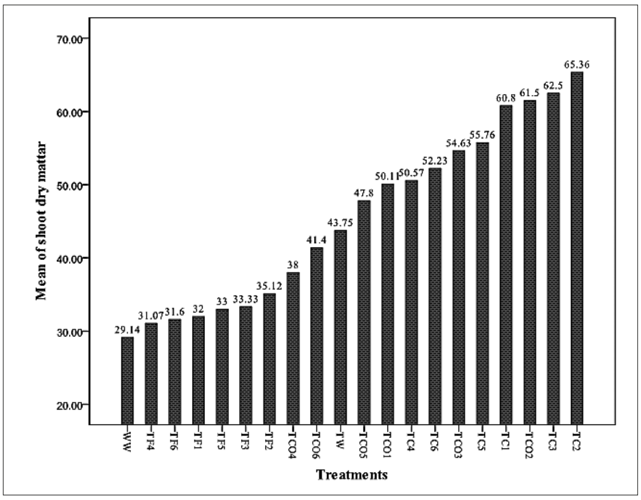

Figure 5. Effect of types of treatment (chemicals, concentrations and physicals) on shoot dry matter (%) seeds *Abelmoschus esculentus* L. (Ladyfinger)

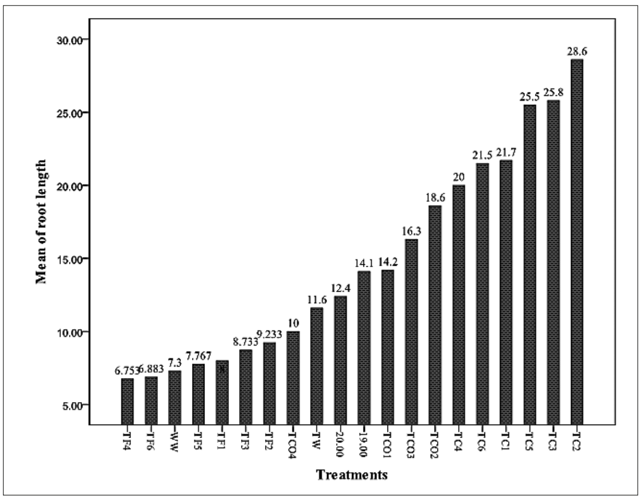

Figure 3. Effect of types of treatment (chemicals, concentrations and physicals) on root length (cm) seeds *Abelmoschus esculentus* L. (Ladyfinger)

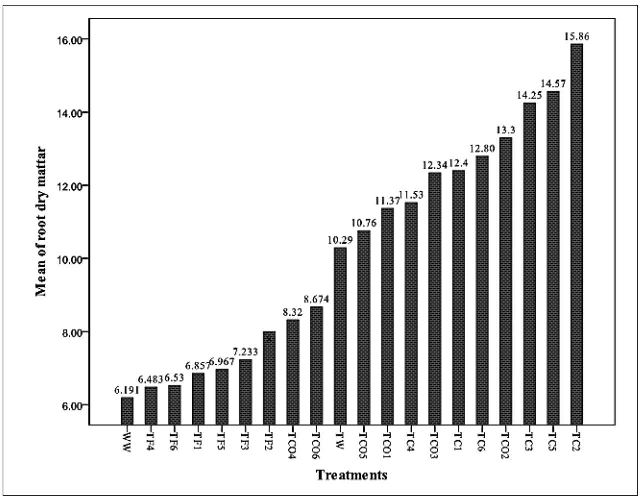

Figure 6. Effect of types of treatment (chemicals, concentrations and physicals) on root dry matter (%) seeds on lady's fingers (*Abelmoschus esculentus* L.)

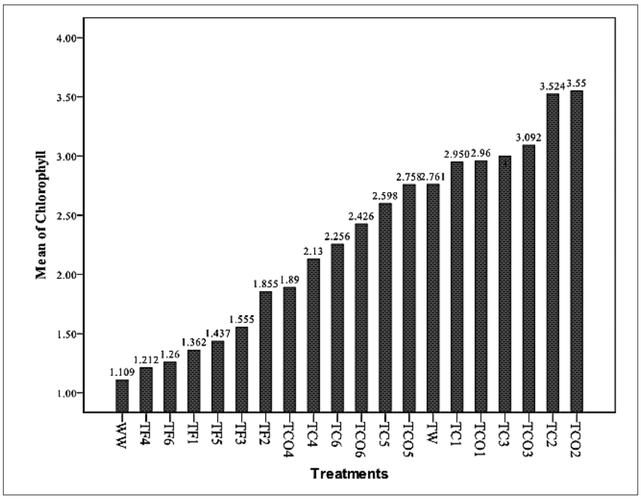

Figure 7. Effect of types of treatment (chemicals, concentrations and physicals) on chlorophyll in green leaves (mg/g fw) seeds on lady's fingers (*Abelmoschus esculentus* L.) (Ladyfinger)

treatments and gave higher average values for all characters under study. There was also an increase in the mean of the averages result the membrane of 1 µm – pH 7.5 and 5 µm with 6.5 pH (TF3 and TF5). Maximum favourable effects were also observed in other treatments that ranged from average to moderate in terms of impact.

Dilution method T3. Seedling growth and dry matter production in lady's fingers (*Abelmoschus esculentus* L.) are shown in Table 4, and seed germination in Fig. 1, 2, 3, 4, 5, 6 and 7. Seedling growth and dry matter production significantly differed with different concentrations and pH values of dairy effluent. The maximum promoting effect was recorded at control and TCO2 (25% –6.5) and TC3 (25% –7.5) (Tab. 4) and a concentration of 50% showed less impact in improving the qualities. All the treatments using concentrations showed an improvement on tap water, while wastewater had a negative impact on the plants. In general, the germination (%) and seedling growth decreased with increase in concentration of the dairy effluent. Germination percentage and seedling growth were inhibited at 100% concentration (Fig 1, 2, 3, 4, 5, 6 and 7).

DISCUSSION

Phytoremediation is an eco-friendly method by which wastewater can be treated to reduce various contaminants which would otherwise be carried into the environment. Different ameliorative techniques improved the quality of effluent by reducing the amount of pollutants present in it, and effectively reduced colour, odour, pH, suspended solids and oxygen demanding waste present in the effluent [10, 15].

Generally, in the presented study, chemical treatment improved the water properties for seed germination and plant growth. These results are consistent with those obtained in [16] where organic impurities removal from the contaminated wastewater of a dairy plant was achieved by coagulation with Aluminum chloride at pH 2–12.

The treated dairy effluent samples using (potassium alum) at different concentrations [(5–25 Mg/ l) $Al_2(SO_4)_3$] showed favourable effects on seed germination and other growth parameters of Maize at 20 Mg/l; the seed germination, seedling growth and dry matter production significantly differed with different treatments which might be due to presence of fewer toxic chemicals in the treated effluent, and the inhibitory effects of raw effluent might be due to the presence of a high level of toxic substances [5, 15]

Also, the results (Tab. 1 and 2) are consistent with study [17] which found that the treatment of dairy wastewater by coagulation-decantation with iron chloride ($FeCl_3.6\ H_2O$), aluminum sulfate ($Al_2\ (SO_4)_3.18\ H_2O$), and calcium hydroxide ($Ca\ (OH)_2$) removed 40% of organic matter and nitrogen content, and improved the treated water.

The germination, seedling growth and dry matter production of lady's fingers (*Abelmoschus esculentus* L.) significantly differed with different treatments using a physical treatment (Fig. 1). The maximum promoting effect was recorded with sand filtrate treatment at 30 minutes [15]. The maximum promoting effect observed in the treated samples might be due to a reduction of pollutants in the filters. Germination percentage, seedling growth and dry matter production were inhibited in raw spent wash. This might be due to osmotic pressure caused by the high dose [10]. Osmotic pressure of the spent wash at higher concentrations of total salts making imbibitions.

The result in Table 4 and Fig 3 are in agreement with [18] which indicated that the length of the root system and number of lateral roots of Vigna radiata increased with low concentrations of effluent. Similar results have been reported by [19, 3], which may be related with the reduction in seedling (root & shoot) lengths with the elevated amounts of total dissolved solids at higher concentrations. This could also be related to the fact that some of the nutrients present in the effluents are essentials, but at high concentrations they become hazardous.

The study of [21] also showed that textile effluents were not inhibitory at low concentrations, but with the increase in concentration, the growth of seedlings was affected. In [22] it was found that tannery effluents caused a reduction in germination and growth of sunflower parameters, together with other parameters, such as chlorophyll content, protein and carbohydrate content, etc.

The effect of fertilizer factory effluents with lower concentrations of effluents promotes seed germination, seedling growth and chlorophyll content, whereas higher doses of effluents inhibited them [23, 15, 24].

The enhancement of chlorophyll could be due to high nutrient uptake, synthesis and translocation, probably facilitated by optimum availability of some of the beneficiary plant nutrients and also due to a reduction in phenol compounds due to the dilution effect. While, decrease at raw effluent (100%) [5, 10, 25].

CONCLUSIONS

The physico-chemical analysis of dairy wastewater revealed that it is highly polluted and its quality can be improved by various method of wastewater treatment by recycling and reusing it for irrigation. *A. esculentus* (lady's fingers) was able to obtain its nutrient requirements from treated effluent which indicates a good establishment in enhancing the growth of plants. Chemical treatment using a dose of 20 mg/l $Al_2(SO_4)_3$ with 6.5 and 7.5 pH showed better results in terms of seed germination, seedling growth, dry matter production and biochemical parameters. Hence, the recycling of treated effluent may indicate a promising future as an alternative source for irrigation in plantations.

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