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Impact of laundry waste water on growth and biochemical characteristics of *Vigna mungo*, L

Impacto de las aguas residuales de lavandería y características bioquímicas y de crecimiento de *Vigna mungo,* L.

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ABSTRACT

A pot culture experiment was conducted to study the effect of laundry waste water on seedling growth of *Vigna mungo*, L. The laundry waste water were collected near Chennai industrial area and their results have been estimated at different concentration of laundry waste water (10 , 25. 50 ,75 and 100%). The results showed that the application different concentration of laundry waste water at 30th days treatment, as resulted significantly decreased of *Vigna mungo*,L compared with control. But the laundry waste water affected at 30th day the plants of *Vigna mungo* L. seedling growth of shoot length, root length, fresh weight, dry weight , Vigor index and biochemical content viz pigment content and carbohydrates, protein was significantly decreased compared with control. The laundry waste water effect leads to decrease the various growth parameters such as seedling growth of the root and shoot. The reduction in all the growth characteristics and biomass accumulation was parallel to decrease in carbohydrate, protein and nucleic acid content of the leaf and an increase in the anthocyanin, L-proline, peroxidase catalase and leaf nitrate activity. Laundry waste water treatment should follow the treatment methods and that treated water to use and increases the soil fertility and the high yielding of crop production. The waste water on proper dilution can be also be materialized as cash by proper sale of the product thus the review fresh up the idea of motility of waste material.

Key words: *Vigna mugo,L ,* Growth and biochemical parameters. Laundry waste water

RESUMEN

Se llevó a cabo un experimento de cultivo en macetas para estudiar el efecto de las aguas residuales de la lavandería sobre el crecimiento de las plántulas de *Vigna mungo*, L. Las aguas residuales de la lavandería se recolectaron cerca del área industrial de Chennai y sus resultados se estimaron con diferentes concentraciones de aguas residuales de la lavandería (10, 25). 50, 75 y 100%). Los resultados mostraron que la aplicación de diferentes concentraciones de aguas residuales de lavandería en el tratamiento del día 30, como resultado, disminuyó significativamente la cantidad de *Vigna mungo*, L en comparación con el control. Pero el agua residual de la lavandería afectó al día 30 las plantas de *Vigna mungo* L., el crecimiento de las plántulas en longitud de brotes, longitud de raíces, peso fresco, peso seco, índice de vigor y contenido bioquímico, es decir, contenido de pigmentos y carbohidratos, la proteína disminuyó significativamente en comparación con el control. El efecto de las aguas residuales de la lavandería conduce a una disminución de diversos parámetros de crecimiento, como el crecimiento de la raíz y el brote de las plántulas. La reducción de todas las características de crecimiento y acumulación de biomasa fue paralela a la disminución del contenido de carbohidratos, proteínas y ácidos nucleicos de la hoja y a un aumento de la actividad de antocianinas, L-prolina, peroxidasa catalasa y nitrato foliar. El tratamiento de aguas residuales de lavandería debe seguir los métodos de tratamiento y el agua tratada que se utilice y aumente la fertilidad del suelo y el alto rendimiento de la producción de cultivos. Las aguas residuales diluidas adecuadamente también pueden materializarse como dinero en efectivo mediante la venta adecuada del producto, por lo que la revisión refresca la idea de la movilidad del material de desecho.

Palabras clave: *Vigna mugo*,L, Crecimiento y parámetros bioquímicos. Aguas residuales de lavandería

INTRODUCTION

Water scarcity has caused great concern worldwide. The reason for water scarcity can be traced to low rainfall and excessive demand due to increased water consumption per capita and increase in population. There is an increasing competition between the agricultural sector and the city inhabitants over the use of drinking water sources and this has led to pressure on these sources. In an attempt to fight this water crisis in the world, the reuse of wastewater and no nordinary kinds of water has increased considerably. Environmental and public health can negatively be affected by the toxic elements contained in grey water. The reuse of untreated grey water in agriculture is now a common practice in parts of the world, mostly areas where farmers have restricted access to fresh water and fertilizer supplies due to low funds. This has led to much concern in the health and environmental implications of untreated or treated wastewater reuse in farm irrigation (Chang *et al.*, 1996). Grey water reuse has posed a number of biological and chemical concerns. Pathogenic microorganisms found in grey water have the ability of causing health problems when ingested by plants. Jeppenson (1996) stated that it was possible for laundry effluent to be diverted into gardens and lawns technically, without treatment. According to Carden *et al.* (2007) grey water has the potential of being used for irrigation because it contains plant nutrients such as organic matter from broken skin, nitrogen and phosphorus compounds. In reality, grey water contributes about 40-50% of the total organic (BOD) load, one-fourth of the total suspended solids and two-thirds of the phosphorus load form in detergents, with various other suspended materials (Christova-Boal *et al.,* 1996) and additives present in detergents (Smulders, 2002). They are also present in other household and personal care products as surfactant (Eriksson *et al.,* 2003). The studies of Abu-Zreig *et al.* (2003) and Shaffran *et al*. (2005) revealed that surfactants in grey water are able to modify the hydraulic conductivity of soils significantly. Wiel Shafran *et al.*, (2006) also stated that significant accumulation of surfactants in soils may result in a water repellent soil and this may pose adverse effects on agricultural productivity and environmental conditions. It is known that linear alkyl benzene sulfonate, a major surfactant in laundry detergents, inhibits plant growth, the activity of soil enzymes and nitrification bacteria. One of the major causes of water pollution is the detergent used for daily laundry.

The aim of this study is to evaluate the reuse potential of laundry greywater by examining growth, and biochemical content of *Vigna mungo,L* which is a common plant in many household gardens in Tamilnadu. In this study, tomato plants were irrigated with laundry greywater and surfactant solutions to separate the effects of detergent surfactants alone on soil-plant system from surfactants combined with other pollutants (as in greywater).

MATERIALS AND METHODS

Collection of laundry waste water: The wastewater used in this treatment process was domestic laundry wastewater (LWW) collected from a washing machine outlet of a family in Chennai, India. The detergent brand, fabric conditioner, and washing machine were maintained the same at full length of the study period.The effluent (LWW) physico- chemical qualities were examined based on the standard procedures (APHA, 2012)

Sample Preservation: The collected samples were preserved as per the standard preservation technique (APHA, 2012). The effluent samples were always kept in a suitable container in a refrigerator at 15 – 20^{o} C. The effluent samples were taken out from the refrigerator only at the time of analyses.

Physico-chemical characters of laundry waste water: The methods of chemical analyses and the measurement procedure for all Water Quality parameters were similar to the standards recommended by Bureau of Indian Standards (BIS). The Physicochemical parameters such as temperature, pH, electrical conductivity, total solids, total dissolved solids, total suspended solids, total hardness, alkalinity, sodium, calcium, magnesium, sulphate, carbonate, bicarbonate, phosphate, chloride, nitrite(NO_2), nitrate (NO_3), dissolved oxygen, biological oxygen demand, chemical oxygen demand were determined and Water Quality Index (WQI) was calculated.

Water Quality Index.

The Water Quality Index of the collected Laundry waste water was calculated to arrive at the level of pollution. (Appendix I)

Appendix-I: Water Quality standards in *ppm*

S.No	Water Quality factor	Standard (desirable) limits (vi)	Reference
1	pH	7.0- 8.5	WHO (1984)
2	Dissloved oxygen	>60	Renn (1970)
3	TDS	<1000	WHO (1984)
4	Total hardness	<500	WHO (1984)
5	Total alkalinity	<120	WHO (1984)
6	Total chlorine	<0.50	Renn (1970)
7	Chloride	<250	WHO (1984)
8	Fluoride	<1.50	WHO (1984)
9	Nitrate	<50	WHO (1984)
10	Phosphorus	<0.10	Renn (1970)
11	Manganese	<0.10	Renn (1970)
12	Chromium	<0.05	BIS (1983)
13	Copper	<0.05	BIS (1983)
14	Iron	<0.03	WHO (1984)
15	Zinc	<5.00	WHO (1984)

The Water Quality Index (WQI) is bound to depend on the indented use of the water. The standards for drinking water recommended (Trivedi, 1988) by BIS for the 10 parameters chosen for the analysis along with the assigned weights (Punmia, 1977).

WQI calculation was carried out as per Harton(1965) as modified by Tiwari and Mishra (1985). Weights (wi) were assigned to various water parameters as indicated in the above table, which ranged from 1-4. According to the role of various parameters on the overall quality of water, the rating scales were fixed. For example, sodium, chloride and sulphate were important parameters in the effluent and hence 4 and 3 weights were assigned. The other parameters were assigned according to their importance and incidence in drinking water. Even if they were present they might not be ruling factor. Hence, they were assigned low weights. The weight(wi) for the ith parameter (i=1,2,…….10 in our case) was calculated from the following relation.

w

Wi = ----- Σ wi=1 --------- (1)

10

Which ensure that 10wi =1 i =1 -------- (2)

The unit weights calculated from the relation shown are indicated in the table. The rating scales for the 10-water quality parameters considered here are given in the following table. Each parameter has been divided into 5 intervals according to the ranges. The quality index (qi) corresponding to various value ranges, in descriptive terms, are given in the following table.

qi- 100 – Ideal limit (BIS)

0-severe value (BIS).

Other ratings namely qi- 25,50 and 75 are intermediate scales between and severe values of BIS for drinking water

Appendix-II

Range of values						
Extent of pollution						
S.NO.	Parameters	Ideal	Slight	Moderate	Extreme	Severe
1	pH	7-8.5	8.6-8.7	8.8-8.9	9.0-9.2	>9.2
2	EC	0-750	700-900	900-1200	1200-1500	>1500
3	Total hardness	50-100	100-150	150-200	200-250	>250
4	TDS	0-700	700-800	800-900	900-1000	>1000
5	Calcium	6-12	12-20	20-26	26-32	>32
6	Magnesium	5-10	10-15	15-18	18-25	>25
7	Chloride	35-70	75-100	100-150	150-250	>250
8	Sulphate	10-15	15-20	20-25	25-30	>30
9	Sodium	25-50	50-75	75-100	100-125	>125
10	Potassium	5-8	8-10	10-12	12-18	>18
	Rating (qi)	100	75	50	25	0

*All the values are expressed in mg/l^{-l} except pH and Electrical conductivity.

The Water Quality Index (WQI) is the aggregate of the multification of qi and wi of the ith parameters.

ie WQI = Σ^{10} qiwi

i- 1.

Based on WQI value the quality status is assigned,ie if WQI is 75 – 100 the parameters are in ideal limit as shown in the above Appendix .

Seed source: Healthy and viable seeds of *Vigna mungo* L. were procured from Seed vendor, certified by Tamilnadu Seed Certification Department, Virudhunagar, Virudhunagar District.

Seedling treatment: Healthy seeds of *Vigna mungo* L. were surface sterilized with 0.1% mercuric chloride for one minute and washed with running tap water and followed by distilled water. Various concentration of the

Laundry waste water was prepared such as 10%, 20%, 30%, 40% and 50%. Seeds were soaked in distilled water for 2 hours. The seeds were allowed to grow in pots containing 9kg of uniformly mixed red, black and sandy soil 1:1:1 ratio. The experimental sets were kept in diffused sunlight at room temperature. The experimental troughs were watered everyday with the respective concentrations of the waste water (750 ml). The control sets were maintained with tap water. Both experimental sets and control sets were maintained in triplicates. On the 21st day, the seedlings were plucked out without any damage and analyzed for the growth parameters like Germination percentage (Carley Watson, 1968), Root length (Buris *et al,* 1969), Shoot length [Arts and Marks, 1971), Fresh weight [Buris *et al,* 1969], Dry weight [Buris *et al,* 1969] and Vigour index (Abdul Baki and Andersn, 1973]. Further the pigments content such as Chlorophyll-*a*, Chlorophyll-*b,* Total Chlorophyll and Caroteniods (Arnon, 1949) The biochemical parameters like total sugar by Jeyaraman, (1981)., total protein by Lowry *et al*., (1951)., l- proline by Bates *et al*., (1973)., free aminoacids (Moore and Stain, 1948)., leaf nitrate (Cataldo *et al.,* (1978)., nitrate reductase activity by Jaworski, (1971)., peroxidase and catalase by Addy and Goodman. (1978) were quantitatively estimated. Triplicates were maintained.

RESULTS AND DISCUSSION

The physico-chemical characteristics of laundry waste water were presented in Table 1. In the present investigation the Laundry waste water showed high values of EC, TDS, sodium, chloride, sulfate, bicarbonate, BOD and COD. Effects of various concentrations of Laundry waste water on the germination percentage and vigour index of *Vigna mugo,L.* were presented in Table 2. The petridish study of germination percentage showed higher percentage in 10% (v/v) concentration and the percentage was gradually decreasing from 25% up to 100% (v/v) concentrations. This decrease may be due to the disturbance of the osmotic relations of the seed and effluent water, thus reducing the amount of water absorption and retarding seed germination. A reduction in germination of wheat at higher concentration of the effluent was observed and it may be due to the higher amount of solids present in the effluent which causes changes in the osmotic relationship of seed and water (Deshmukh *et al*.,2004).

Other growth characteristics were measured from the seedlings grown 30 days after sowing. At 10% (v/v) concentration higher amount of shoot length and root length was observed. Effects of various concentrations of laundry waste water on the growth of *Vigna mugo,L.* were presented in Table 3.At higher concentrations of laundry waste water both root and shoot lengths were affected. An increase in root and shoot length in *Brassica* at 25% concentration of the distillery effluent and a decrease in root and shoot length at higher concentrations was reported (Deshmukh *et al.,* 2004). The Fresh Weight (FW) and Dry Weight (DW) of seedlings recorded more at 10% (v/v) concentration and decreased at the higher concentrations of the effluent. The presence of optimum level of nutrients in the lower concentration of the effluent might have increased both FW and DW. A reduction in fresh and dry weight was also observed in chick pea with increasing concentration of the distillery effluent (Richa Rani, Parul and Ila Prakash, 2016).

Effect of various concentrations of laundry waste water on the pigments content of *Vigna mungo,L* is revealed in the Table 4. Among the various dilution factors, 10% dilution showed good amount of Chlorophyll-*a*, Chlorophyll-*b*, Total Chlorophyll and Carotenoid contents than other dilutions. A similar trend was reported in *Phaseolus aureus* (Parvathi *et al.,* 2014). An increase in chlorophyll a, b and total chlorophyll content at lower concentration of distillery effluent might be due to presence of optimum conditions of nutrient element such as Mg and K required for pigment biosynthesis. Reduction in the pigments content was observed when the concentration of the effluent was increased from 20% up to 50% (v/v). Reduction in chlorophyll induced by higher concentration of effluent may be associated with mineral ions. It may also due to the formation of enzymes chlorophyllase which is responsible for chlorophyll degradation (Shyam Veer Singh and Swami 2014). The inhibition of chlorophyll synthesis may be due to the induced inhibition of electron transport system in Photosystem (PS) II. Increasing concentration of wastewater is inhibitory to synthesis of chlorophyll molecules (Khan *et al*., 201). A decrease in carotenoid content at higher concentration of textile effluent was reported (Bhaskaran et al 2009).

The percentage of reduction in observation in various biochemical characteristics of plant species. The effect of laundry waste water revealed significant reduction of pigment. Chlorophyll- a, chlorophyll – b, total chlorophyll and carotenoids content when compared to those of control plants. The soluble protein content was found to decrease with laundry waste water treated plant species. The reduction observed in the leaf protein level directly to the photosynthetic product, namely sugar. The total sugar content was found to be reduced in all the polluted area plant species. The reduction in protein content also correlated to increase in the accumulation of free acids. The liberated aminoacid L-proline accumulated more in polluted area plants. The *in vivo* reductase (NR) activity was found in decreased polluted area plant. The decrease NR activity can be correlated to increase leaf nitrate content. Reduction in protein synthesis and altered NR activity observed in the present study may also related to decline enzymatic study. The activity of enzyme such as peroxidase and catalase was found to decrease in laundry waste water treated crop plants.

The present study showed that Laundry waste water had an adverse effect on growth and biochemical content of *Vigna mungo,L* at higher concentration (100%). But in lower concentration (10%) when compared to control, there was an enhancement in its growth parameters which may be due to the presence of optimum level of nutrients in the laundry waste water. Laundry waste water treatment should follow the treatment methods and that treated water to use and increases the soil fertility and the high yielding of crop production. The waste water on proper dilution can be also be materialized as cash by proper sale of the product thus the review fresh up the idea of motility of waste material.

Table -1. Physico chemical characteristics of laundry waste water

S.No	Parameters	Values/Characters
1	pH	7.8
2	Color	Grey
3	Temperature	30
4	Electrical conductivity	16,032
5	Total solids	12,252
6	Total dissolved solids	12,025
7	Total suspended solids	227
8	Total hardness	234
9	Salinity	24.25
10	Sodium	102.3
11	Potassium	23.73
12	Calcium	12.16
13	Magnesium	11.23
14	Sulphate	31.23
15	Chloride	324.3
16	Nitrogen	10.1
17	Phosphate	8.95
18	COD	324.5
19	Dissolved Oxygen	Nil
20	Cadmium	1.26
21	Lead	2.22
20	BOD	5423

All the values are mg/$^{l-1}$ except EC (mmhos)

Table -2. Impact of laundry waste water and growth performance of *Vigna mungo,* L.

S.No	Parameters	Control	Concentration of laundry waste water(%)				
			10	25	50	75	100
1	Germination (%)	100	95±0.08	85±0.06	65±0.06	35±0.05	10±0.02
2	Shoot length (cm)	25.2±0.09	22.1±0.2	18.0±0.5	12.1±0.5	8.2±0.04	4.0±0.07
3	Root length(cm)	8.2±0.05	7.9±0.07	6.5±0.03	3.4±0.05	2.1±0.06	1.0±0.05
4	Fresh weight (g)	2.0±0.05	1.8±0.05	1.1±0.07	0.9±0.07	0.5±0.03	0.1±0.05
5	Dry weight (g)	1.0±0.06	0.8±0.07	0.2±0.07	-	-	-
6	Vigour Index	3340±0.01	2774±0.04	2082.5±0.06	1007.5±0.05	360.5±0.06	50±0.02

All the values average of three observations. Mean ± S.E

Table -3

Impact of laundry waste water and biochemical content of *Vigna mungo,* L.

S.No	Parameters*	Control	Concentration of laundry waste water(%)				
			10	25	50	75	100
1	Chlorophyll -*a*	0.980 ± 0.07	0.950 ± 0.080	0.880 ± 0.070	0.650 ± 0.040	0.450 ± 0.050	0.229 ± 0.060
2	Chlorophyll -*b*	0.650 ± 0.06	0.620 ± 0.060	0.530 ± 0.080	0.350 ± 0.070	0.230 ± 0.060	0.120 ± 0.060
3	Total Chlorophyll	1.63 ± 0.04	1.570 ± 0.050	1.410 ± 0.060	1.000 ± 0.030	0.680 ± 0.020	0.349 ± 0.090
4	Anthocyanin	2.20 ± 0.02	2.500 ± 0.034	3.200 ± 0.034	3.700 ± 0.040	4.200 ± 0.054	5.700 ± 0.070
5	Carbohydrates	58.20 ± 0.06	55.300 ± 0.050	45.340 ± 0.040	35.540 ± 0.070	22.230 ± 0.050	20.650 ± 0.090
6	Protein	12.34 ± 0.07	10.340 ± 0.070	9.290 ± 0.050	5.340 ± 0.010	2.340 ± 0.070	1.010 ± 0.050
7	Free amino acids	10.30 ± 0.035	12.220 ± 0.054	18.230 ± 0.040	20.230 ± 0.020	23.300 ± 0.030	25.300 ± 0.030
8	L-proline	2.50 ± 0.04	2.800 ±0.030	3.200 ± 0.040	3.600 ± 0.090	4.200 ± 0.050	4.900 ± 0.060
9	Leaf nitrate	22.20 ± 0.03	25.100 ±0.040	28.300 ±0.030	31.300 ± 0.090	33.200 ± 0.030	35.400 ± 0.040
10	Nitrate reductase	10.20 ± 0.02	9.800 ± 0.030	9.200 ± 0.040	8.300 ± 0.030	8.100 ± 0.040	7.500 ± 0.040
11	Peroxidase	0.92 ± 0.03	1.200 ± 0.040	1.500 ± 0.030	2.200 ± 0.040	2.800 ± 0.050	3.100 ± 0.050
12	Catalase	1.20 ± 0.03	1.300 ± 0.010	2.100 ± 0.040	2.300 ± 0.050	2.800 ± 0.040	2.900 ± 0.070
13	D. N.A	1.30 ± 0.04	1.200 ±0.040	1.900 ± 0.040	2.300 ± 0.060	2.600 ± 0.050	2.800 ± 0.040
14	R.N.A	1.10 ± 0.05	1.000 ± 0.020	0.960 ± 0.040	0.920 ± 0.070	0.850 ± 0.050	0.500 ± 0.070

* mg/g fresh wt. All the values average of three observations. Mean ± S.E

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