Biomedical & Pharmacology Journal Vol. **3**(1), 55-61 (2010)

Influence of distillery spentwash irrigation on the nutrients uptake of herbal medicinal plants in normal and spentwash treated soil

S. CHANDRAJU*, R. NAGENDRASWAMY[1], C.S. CHIDANKUMAR[2] and GIRIJANAGENDRA SWAMY[3]

Department of Studies in Sugar Technology, Sir M.Visweswaraya Postgraduate Center, University of Mysore, Tubinakere, Mandya - 571 402 (India).
[1]Department of Chemistry, Govt. First College, Hanagodu, Mysore Dt., Karnataka (India).
[2]Department of Chemistry, Bharathi College, Bharathi Nagar - 571 422 (India).
[3]Department of Chemistry, Maharani's Science College, Mysore - 570 005 (India).

(Received: April 15, 2010; Accepted: May 05, 2010)

ABSTRACT

Cultivation of some herbal medicinal plants was made by irrigation with distillery spentwash of different proportions. The spentwash i.e., primary treated spentwash (PTSW) and 33% spentwash were analyzed for their plant nutrients such as nitrogen, phosphorous, potassium and other physical and chemical parameters. Experimental soils i.e, normal soil (plot-1) and spentwash treated (plot-2) soils were tested for their chemical and physical parameters. herbal medicinal plants, namely, Tulsi *(Ocimum sanctum)*, Kama kasturi *(Ocimum basilicum)* and Thumbe *(Leucas asper)* seeds (Namadhari and Mayhco) were sowed in the prepared land and irrigated with raw water (RW) and 33% spent wash. Influence of spentwash in normal and spentwash treated soils on proximate principles (moisture, protein, fat, fiber, carbohydrate, energy, calcium, phosphorous, and iron), Vitamin content (carotene and vitamin-c), minerals and trace elements (magnesium, sodium, potassium, copper, manganese, zinc, chromium and nickel) were investigated at their respective maturity. It was found that the nutrients of all plants were high in 33% than raw water irrigation. Further, the nutritive values were very high in spentwash treated soil (plot-2) than normal soil (plot-1) and raw water irrigations for all plants.

Key words: Distillery spentwash, Medicinal plants, Nutrients, Proximate principles, Normal soil, Spentwash Treated soil

INTRODUCTION

Molasses (one of the important byproducts of sugar industry) is the chief source for the production of ethanol in distilleries by fermentation method. About eight (08) liters of waste water is discharged for every lifer of ethanol production in distilleries, known as raw spentwash (RSW), which is characterized by high biochemical oxygen demand (BOD: 5000-8000mg/L) and chemical oxygen demand (COD: 25000-30000mg/L)(Joshi, *et al.,*), undesirable color and foul smell. Discharge of raw spentwash into open land or near by water bodies resulting in a number of environmental, water and soil pollution including threat to plant and animal lives. Hence, discharge of spentwash is a serious problem.

The RSW is highly acidic and contains easily oxidizable organic matter with very high BOD and COD (Patil *et al.,*). Also, spent wash contains highest content of organic nitrogen and nutrients (Ramadurai and Gearard, 1987). By installing biomethenation plant in distilleries, reduces the oxygen demand of RSW, the resulting spentwash is called primary treated spentwash (PTSW) and primary treatment to RSW increases the nitrogen (N), potassium (K), and phosphorous (P) contents

and decreases the calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl^-), and sulphate (SO_4^{2-}) (Mahamod Haroon and Subhash Chandra Bose,2004). The PTSW is rich in potassium (K), sulphur (S), nitrogen (N), phosphorous (P) as well as easily biodegradable organic matter and its application to soil has been reported to be beneficial to increase sugarcane (Zalawadia *et al.,* 1997), Rice (Devarajan and Oblisami, 1998), Wheat and Rice yield (Pathak *et al.,* 1998), quality of Groundnut (Amar Singh *et al.,* 2003) and physiological response of Soybean (Ramana *et al.,* 2000). Diluted spentwash could be used for irrigation purpose without adversely affecting soil fertility (Kaushik *et al.,* 2005; Kuntal *et al.,* 2004; Raverkar *et al.,* 2000), seed germination and crop productivity (Ramana *et al.,* 2001). The diluted spentwash irrigation improved the physical and chemical properties of the soil and further increased soil microflora (Devarajan *et al.,* 1994). Twelve pre sowing irrigations with the diluted spentwash had no adverse effect on the germination of Maize but improved the growth and yield (Singh and Raj Bahadur, 1998). Diluted spentwash increases the

Table 1: Chemical composition of distillery spentwash

Chemical parameters	PTSW	33% PTSW
pH	7.57	7.65
Electrical conductivity[a]	26400	7620
Total solids[b]	47200	21930
Total dissolved solidsb	37100	12080
Total suspended solids[b]	10240	4080
Settleable solids[b]	9880	2820
COD[b]	41250	10948
BOD[b]	16100	4700
Carbonate[b]	Nil	Nil
Bicarbonate[b]	12200	3300
Total Phosphorous[b]	40.5	17.03
Total Potassium[b]	7500	2700
Calcium[b]	900	370
Magnesium[b]	1244.16	134.22
Sulphur[b]	70	17.8
Sodium[b]	520	280
Chlorides[b]	6204	3404
Iron[b]	7.5	3.5
Manganese[b]	980	288
Zinc[b]	1.5	0.63
Copper[b]	0.25	0.048
Cadmium[b]	0.005	0.002
Lead[b]	0.16	0.06
Chromium[b]	0.05	0.012
Nickel[b]	0.09	0.025
Ammonical Nitrogen[b]	750.8	283.76
Charbohydrates[c]	22.80	8.12

Units: a –µS, b – mg/L, c- %, PTSW - Primary treated distillery spentwash

Table 2: Amounts of N, P, K and S (nutrients) in distillery spentwash

Chemical parameters	PTSW	33% PT SW
Ammonical Nitrogen[b]	750.8	283.76
Total Phosphorous[b]	40.5	17.03
Total Potassium[b]	7500	2700
Sulphur[b]	70	17.8

Unit: b – mg/L, PTSW - Primary treated distillery spentwash

Table 3: Characteristics of experimental soils

Parameters	Plot-1	Plot-2
Coarse sand[a]	9.85	10.98
Fine sand[a]	40.72	42.74
Slit[a]	25.77	26.43
Clay[a]	23.66	18.46
pH (1:2 soln) [a]	8.41	8.32
Organic carbon[a]	1.77	1.98
Electrical conductivityb[b]	540	471
Available Nitrogen[c]	402	518
Available Phosphorous[c]	202	256
Available Potassium[c]	113	108
Exchangeable Calcium[c]	185	198
Exchangeable Magnesium[c]	276	240
Exchangeable Sodium[c]	115	195
Available Sulphur[c]	337	310
DTPA Iron[c]	202	242
DTPA Manganese[c]	210	250
DTPA Copper[c]	12	15
DTPA Zinc[c]	60	75

Plot-1: Normal Soil;

Plot-2: Spentwash treated Soil Units: a- %; b- µS; c-ppm

growth of shoot length, leaf number per plant, leaf area and chlorophyll content of peas (Rani and Srivastava, 1990). Increased concentration of spentwash causes decreased seed germination, seedling growth and chlorophyll content in Sunflowers (Helianthus annuus) and the spentwash could safely used for irrigation purpose at lower concentration (Rajendran,1990; Ramana *et al.,*2001). The spentwash contained an excess of various forms of cations and anions, which are injurious to plant growth and these constituents should be reduced to beneficial level by diluting the spent wash, which can be used as a substitute for chemical fertilizer (Sahai *et al.,* 1983). The spent wash could be used as a complement to mineral fertilizer to sugarcane (Chares, 1985). The spent wash contained N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation with water (Samuel, 1986). The application of diluted spentwash increased the uptake of Zinc (Zn), Copper (Cu), Iron (Fe) and manganese (Mn) in Maize and Wheat as compared to control and the highest total uptake of these were found at lower dilution levels than at higher dilution levels (Pujar,1995). Mineralization of organic material as well as nutrients present in the spentwash was responsible for increased availability of plant nutrients. Diluted spent wash increase the uptake of nutrients, height, growth and yield of Leaves vegetables (Chandraju *et al.,* 2008; Basavaraju and

Table 4: Nutritive values of Tulsi (*Ocimum sanctum*) in plot-1 & 2

Parameters	Plot-1		Plot-2	
	RW	33%PTSW	RW	33%PTSW
Moisture[a]	12.0	12.3	12.0	12.5
Fat[a]	0.64	0.69	0.78	0.92
Acid insoluble Ash[a]	0.45	0.45	0.45	0.48
Protein[a]	2.9	3.0	3.1	3.4
Fibre[a]	1.60	1.7	1.7	1.9
Carbohydrate[a]	2.65	3.25	2.70	3.96
Energy[b]	23.0	32.0	28.0	36.6
Calcium[c]	177.0	180.0	182.0	192.2
Magnesium[c]	60.0	63.0	62.0	64.2
Sodium[c]	4.0	8.0	6.4	9.4
Potassium[c]	250.0	280.0	255.0	296.0
Iron[c]	3.85	6.0	4.2	8.6
Phosphorous[c]	30.0	35.0	33.2	38.4
Zinc[c]	0.25	0.58	0.46	0.82
Manganese[c]	0.25	0.59	0.36	0.83
Copper[c]	0.08	0.09	0.09	1.0
Chlorides[c]	0.65	0.70	0.68	0.74
Lead[c]	Nil	Nil	Nil	Nil
Cadmium[c]	Nil	Nil	Nil	Nil
Chromium[c]	0.002	0.002	0.002	0.002
Nickel[c]	0.002	0.002	0.002	0.002
Sulfur[c]	100.0	108.0	104.2	109.8
Carotene[d]	3100	3125	3200	3321
Vitamin C[c]	18.0	22.0	19.5	24.6

a-g; b-k.cal; c-mg; d-µg; RW-Raw water

PTSW-Primary treated spentwash

Plot-1: Normal soil; Plot-2: Spentwash treated soil

Chandraju. 2008), nutrients of Cabbage and Mint leaf (Chandraju *et al.,* 2008), nutrients of Top vegetable (Basavaraju and Chandraju, 2008), Pulses, Condiments and Root vegetables (Chandraju *et al.,* 2008), nutrients of Pulses in normal and treated soil (Chidankumar and Chandraju, 2008).

However, not much information is available on the studies of distillery spentwash on the nutrients of herbal medicinal plants in normal and spentwash treated soil. Therefore, the present investigation was carried out to investigate the influence of different concentration of spentwash on the nutrients of herbal medicinal plants in normal and spentwash treated soils.

MATERIAL AND METHODS

Physico-chemical parameters and amount of nitrogen (N), potassium (K), phosphorous (P) and sulphur (S) present in the primary treated spentwash and 33% spentwash were analyzed by standard methods (Tables - 1 and 2). The PTSW was used for irrigation with a dilution of 33% in plot-1 and plot-2. Before initiation, plot-2 soil was treated with diluted spentwash for four times, with an interval of one week, each time land was ploughed and exposed to sunlight. A composite soil samples from both plots were collected at 25 cm depth, air-dried, powdered and analyzed for physico-chemical properties (Table-3).

Table 5: Nutritive values of Kama kasturi (*Ocimum basilicum*) in plot-1 & 2

Parameters	Plot-1		Plot-2	
	RW	33%PTSW	RW	33%PTSW
Moisture[a]	90.96	90.98	90.97	90.99
Fat[a]	0.61	0.64	0.75	0.80
Acid insoluble Ash[a]	0.25	0.28	0.30	0.31
Protein[a]	2.54	3.15	2.74	3.55
Fibre[a]	1.60	3.9	1.6	4.1
Carbohydrate[a]	2.0	4.62	4.8	5.46
Energy[b]	23.0	27.0	28.2	39.0
Calcium[c]	154.0	177.0	156.0	178.4
Magnesium[c]	64.0	81.0	69.0	96.0
Sodium[c]	14.0	25.0	14.4	25.8
Potassium[c]	295.0	462.0	298.0	465.0
Iron[c]	3.17	3.18	3.2	3.4
Phosphorous[c]	29.0	69.0	42.6	78.8
Zinc[c]	0.72	0.85	0.82	0.89
Manganese[c]	1.15	1.45	1.19	1.48
Copper[c]	0.19	0.385	0.20	0.40
Chlorides[c]	25	35.0	25.8	35.9
Lead[c]	Nil	Nil	Nil	Nil
Cadmium[c]	Nil	Nil	Nil	Nil
Chromium[c]	0.001	0.001	0.001	0.001
Nickel[c]	0.001	0.001	0.001	0.001
Sulfur[c]	10.0	20.0	12.2	22.5
Carotene[d]	80.0	109.0	98.4	120.6
Vitamin C[c]	10.0	18.0	11.5	20.4

a-g; b-k.cal; c-mg; d-µg; RW-Raw water
PTSW-Primary treated spentwash
Plot-1: Normal soil; Plot-2: Spentwash treated soil

Herbal medicinal plants selected for present investigation were *Tulsi (Ocimum sanctum)*, Kama kasturi *(Ocimum basilicum)* and Thumbe *(Leucas asper).* The seeds were sowed and irrigated with raw water (RW) and 33% spentwash in both plots at the dosage of twice a week and rest of the period with raw water depends upon the climatic condition. At the maturity time, plants were harvested and proximate principles, vitamins, minerals and trace elements were analyzed. Cultivation of medicinal plants was repeated for three times in each case, all parameters were determined and average values were recorded.

RESULTS AND DISCUSSION

Chemical composition of PTSW and 33% spentwash such as pH, electrical conductivity, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), settelable solids (SS), chemical oxygen demand (COD), biological oxygen demand (BOD), carbonates, bicarbonates, total phosphorous (P), total potassium (K), ammonical nitrogen (N), calcium (Ca), magnesium (Mg), sulphur (S), sodium (Na), chlorides (Cl), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), cadmium (Cd), lead (Pb), chromium (Cr) and nickel (Ni) were analyzed and tabulated (Table-1). Amounts of N, P, K and S contents are presented in Table-2.

Table 6: Nutritive values of Thumbe [*Leucas aspera*) in plot-1 & 2

Parameters	Plot-1		Plot-2	
	RW	33%PTSW	RW	33%PTSW
Moisture[a]	80.2	80.6	80.3	80.7
Fat[a]	0.08	0.09	0.09	1.0
Acid insoluble Ash[a]	0.25	0.26	0.26	0.27
Protein[a]	0.4	0.62	0.60	0.82
Fibre[a]	0.3	0.33	0.32	0.36
Carbohydrate[a]	5.2	6.0	5.8	6.9
Energy[b]	20.0	26.0	25.0	30.2
Calcium[c]	40.0	56.0	45.3	64.2
Magnesium[c]	8.0	16.5	11.4	18.1
Sodium[c]	20.0	24.0	22.3	24.8
Potassium[c]	8.0	9.2	8.8	10.2
Iron[c]	0.3	0.39	0.4	0.48
Phosphorous[c]	25.0	28.0	26.3	29.6
Zinc[c]	0.15	0.23	0.18	0.27
Manganese[c]	0.10	0.10	0.10	0.10
Copper[c]	0.09	0.13	0.10	0.13
Chlorides[c]	20.0	27.0	20.6	27.9
Lead[c]	Nil	Nil	Nil	Nil
Cadmium[c]	Nil	Nil	Nil	Nil
Chromium[c]	0.001	0.001	0.001	0.001
Nickel[c]	0.001	0.001	0.001	0.001
Sulfur[c]	15.0	19.0	16.6	19.8
Carotene[d]	100.0	148.0	129.2	156.4
Vitamin C[c]	20.0	23.0	22.3	14.9

a-g; b-k.cal; c-mg; d-µg; RW-Raw water

PTSW-Primary treated spentwash

Plot-1: Normal soil; Plot-2: Spentwash treated soil

Characteristics of experimental soils(Plot-1 & plot-2) such as pH, electrical conductivity, the amount of organic carbon, available nitrogen (N), phosphorous (P), potassium (K), sulphur (S) exchangeable calcium (Ca), magnesium (Mg), sodium (Na), DTPA iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) were analyzed (Manivasakam, 1987:Subbaiah and Asija, 1956: Piper, 1966: Walkeley and Black,1934: Jackson, 1973: Black,1965: Lindsay and Norvel, 1978)and tabulated (Table-3).

Uptakes of all the parameters were very good in 33% spentwash irrigation than compared to raw water rrigaion in both fields (plots1&2) for all plants. However considerable uptake of the nutrients is very high in plot-2 than plot-1 in all types of irrigations for all plants and there was no negative impact of spentwash on the nutrients (Tables: 4-6).

CONCLUSION

It was noticed that the nutrients uptake in all medicinal plants were largely influenced in case of 33% diluted spentwash irrigation than with raw water in spentwash treated soil than normal soil. This concludes that, the spentwash treated soil is enriched with the plant nutrients such as nitrogen, potassium and phosphorous. It further concludes that, the subsequent use of diluted spentwash for irrigation enriches the soil fertility and hence the diluted spentwash (33%) is effective eco-friendly irrigation medium for cultivation of medicinal plants without any adverse effect.

REFERENCES

1. Amar, B.S. Ashisk, B. and Sivakoti, R. Effect of distillery effluent on plant and Soil enzymatic activities and ground nut quality. *Journal of Plant Nutrition and Soil Science*, **166:** 345-347**.** (2003).
2. Basavaraju ,H.C. and Chandraju, S. Impact of distillery spent wash on the Nutrients of Leaves vegetables: An Investigation. *Asian J. of Chem.* **20** (7): 5301- 5310. (2008).
3. Basavaraju ,H.C. and Chandraju, S. An Investigation of Impact of distillery Spentwash on the nutrients of Top Vegetables. *Internat.J.Agric. Sci*, **4**(2): 691-696. (2008).
4. Chares, S . Vinasse in the fertilization of sugarcane. Sugarcane, **1,** 20. (1985).
5. Chandraju, S. and Basavaraju, H.C. Impact of distillery spent wash on Seed germination and growth of leaves Vegetables: An investigation. *Sugar Journal* (SISSTA). **38**: 20-50 (2007).
6. Chandraju, S. Basavaraju, H.C. and Chidankumar, C.S. Investigation of Impact of Irrigation of distillery spent wash on the nutrients of cabbage and Mint leaf. *Indian Sugar*, 19-28 (2008).
7. Chandraju, S. Basavaraju, H.C. and Chidankumar, C.S. Investigation of Impact of Irrigation of distillery spent wash on the nutrients of pulses. *Asian J. Chem*. **20**(8): 6342-6348 (2008).
8. Chidankumar, C.S. and Chandraju,S. Impact of distillery spentwash Irrigation on the nutrients of pulses in untreated and treated soil. *Sugar Tech*, **10**(4): 314-318 (2008).
9. Deverajan , L.and Oblisami, G. Effect of distillery effluent on soil fertility Status, yield and quality of rice. *Madras Agricultural Journal*, **82**: 664-665 (1995).
10. Devarajan, L. Rajanna, G. Ramanathan, G. and Oblisami, G. Performance of field crops under distillery effluent irrigations, *Kisan world*, **21:** 48-50. (1994).
11. Joshi,H.C. Kalra, N. Chaudhary, A. and Deb, D.L. Environmental issues Related with distillery effluent utilization in agriculture in India, Asia *Pac J Environ. Develop*, **1:** 92-103. (1994).
12. Kaushik,K. Nisha, R.,Jagjeeta, K. and Kaushik,C.P. Impact of long and Short term irrigation of a sodic soil with distillery effluent in combination with Bio-amendments. *Bioresource Technology*, **96**(17): 1860-1866 (2005).
13. Kuntal, M.H. Ashis,K. Biswas, A.K. and Misra, K. Effect of post- Methanation effluent on soil physical properties under a soybean-wheat system In a vertisol. *Journal of Plant*

Nutrition and Soil Science. **167(**5): 584-590 (2004).

14. Mohamed Haroon, A.R. and Subash Chandra Bose, M. Use of distillery spentwash for alkali soil reclamation, treated distillery effluent for ferti irrigation of Crops. *Indian Farm*, March, 48- 51 (2004).
15. Patil ,J.D. Arabatti, S.V. and Hapse, D.G. A review of some aspects of Distillery spentwash (vinase) utilization in sugar cane, Bartiya sugar 9-15 (1987).
16. Pathak, H. Joshi, H.C. Chaudhary, A. Chaudhary, R. Kalra, N. and Dwivedi, M.K. Distillery effluent as soil amendment for wheat and rice. *Journal of Indian Society for Soil Science*. **46:** 155-157 (1998).
17. Pujar, S.S. Effect of distillery effluent irrigation on growth, yield and Quality of crops. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad. (1995).
18. Ramadurai, R. and Gearard, E.J. Distillery effluent and downstream Products, SISSTA, *Sugar Journal.* **20:** 129-131**.** (1994).
19. Raverkar, K.P. Ramana, S. Singh, A.B. Biswas, A.K. and Kundu, S. Impact of post methanated spent wash (PMS) on the nursery raising, biological Parameters of Glyricidia sepum and biological activity of soil. *Ann. Plant Research*, **2(**2): 161-168 (2000).
20. Ramana, S. Biswas, A.K. Kundu, S. Saha, J.K. and Yadava, R.B.R. Effect of distillery effluent on seed germination in some vegetable crops. *Bio-resource Technology*, **82**(3): 273-275 (2001).
21. Rani, R. and Sri Vastava, M.M. Eco-physiological response of Pisum sativum and citrus maxima to distillery effluents. *Int. J. of Ecology and Environ. Science*, 16-23 (1990).
22. Rajendran ,K. Effect of distillery effluent on the seed germination, Seedling growth, chlorophyll content and mitosis in Helianthus Annuus. *Indian Botanical Contactor*, **7**: 139-144 (1990).
23. Ramana, S. Biswas, A.K. Kundu, S. Saha, J.K. and Yadava,R.B.R. Physiological response of soybean (Glycine max L.) to foliar application of Distillery effluent. *Plant Soil Research*, **2**: 1-6 (2000).
24. Singh ,Y. and Raj Bahadur. Effect of application of distillery effluent on Maize crop and soil properties. *Indian J. Agri. Science,* **68:** 70-74. (1998).
25. Sahai, R. Jabeen, S. and Saxena, P.K. Effect of distillery waste on seed Germination, seedling growth and pigment content of rice. *Indian Journal of Ecology*, **10:** 7-10. (1983).
26. Samuel, G. The use of alcohol distillery waste as a fertilizer, Proceedings of International American Sugarcane Seminar.245-252. (1986).
27. Zalawadia, N.M. Ramana, S. and Patil,R.G. Influence of diluted spent wash of sugar industries application on yield and nutrient uptake by sugarcane and Changes in soil properties. *Journal of Indian Society for Soil Science.* **45**: 767- 769 (1997)**.**