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Original Research Paper

Influence of Distillery Spentwash Irrigation on Nutrients of *Ginger* (*Zingiber officinale*) and Turmeric (*Curcuma longa*) Medicinal Plants in Normal and Spentwash Treated Soil

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ABSTRACT

Cultivation of some medicinal plants, ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) was made by irrigation with distillery spentwash of different proportions. The spentwash i.e., primary treated spentwash (PTSW) and 33% spentwash were analysed for their plant nutrients such as nitrogen, phosphorus, potassium and other physical and chemical parameters. Experimental soils i.e., normal soil and spentwash treated soils were tested for their chemical and physical parameters. Cultivation was done by irrigated with raw water (RW) and 33% spentwash. Influence of spentwash in normal and spentwash treated soils on proximate principles (moisture, protein, fat, fiber, carbohydrate, energy, calcium, phosphorus, iron), vitamin content (carotene and vitamin-C), minerals and trace elements (magnesium, sodium, potassium, copper, manganese, zinc, chromium, nickel) of plants were investigated at their respective maturity. It was found that the nutrients of all medicinal plants were high in 33% than raw water irrigation. Further, the nutritive values were very high in spentwash treated soil than normal soil and raw water irrigations.

INTRODUCTION

Molasses is the chief source for the production of ethanol in distilleries by fermentation method. About eight litres of wastewater is discharged for every litre of ethanol production in distilleries, known as raw spentwash (RSW), which is characterized by high biochemical oxygen demand (5000-8000 mg/L) and chemical oxygen demand (25000-30000mg/L) (Joshi et al. 1994), undesirable colour and foul smell. The RSW is highly acidic and contains easily oxidizable organic matter (Patil et al. 1987). Spent wash also contains high content of organic nitrogen and nutrients (Ramadurai & Gearard 1994). Discharge of raw spent wash into open land or nearby 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 major problem.

By installing biomethanation plant in distilleries, oxygen demand of RSW can be reduced and the resulting spentwash is called primary treated spent wash (PTSW). Primary treatment to RSW increases nitrogen (N), potassium (K), and phosphorus (P) contents and decreases calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl^-) and sulphate (SO_4^{2-}) (Mohamed Haroon & Subhash Chandra Bose2004). The PTSW is rich in potassium (K), sulphur (S), nitrogen (N), phosphorus (P)

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 solids[b]	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 Phosphorus[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 phosphorus[b]	40.5	17.03
Total potassium[b]	7500	2700
Sulphur[b]	70	17.8

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

as well as easily biodegradable organic matter. Its application to soil has been reported to be beneficial to increase sugar cane (Zalawadia et al. 1997), rice (Devarajan & Oblisami 1995), wheat and rice yield (Pathak et al.1998), quality of groundnut (Amar Singh et al. 2003) and physiological response of soybean (Ramana et al. 2001). Diluted spentwash could be used for irrigation without adversely affecting soil fertility (Kaushik et al. 2005, Kuntal et al. 2004, Raverkar et al. 2000) and 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 presowing irrigations with the diluted spentwash had no adverse effect on the germination of maize but improved the growth and yield (Singh & Raj Bahadur 1998). Diluted spentwash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content of peas (Rani & Srivastava 1990). Increased concentration of spentwash causes decreased seed germination, seedling growth and chlorophyll content in sunflower (*Helianthus annuus*) and the spentwash could safely used for irrigation at lower concentration (Rajendran 1990, Ramana et al. 2000). 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 spentwash, which can be used as a substitute for chemical fertilizer (Sahai et al. 1983). The spentwash could be used as a complement to mineral fertilizer to sugar cane (Chares 1985). The spentwash 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, copper, iron and manganese 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 spentwash increases the uptake of nutrients, height, growth and yield of leafy vegetables (Chandraju et al. 2008, Basavaraju & Chandraju 2008), nutrients of cabbage and mint leaf (Chandraju et al. 2008), nutrients of top vegetable (Basavaraju & Chandraju 2008), pulses, condiments and root vegetables (Chandraju et al. 2008), nutrients of pulses in normal and treated soil (Chidankumar & Chandraju 2008).

However, no information is available on the impact of distillery spentwash irrigation on the nutrients of ginger (*Zingiber officinale*) and turmeric (*Curcuma longa)* medicinal plants in normal and spentwash treated soil. Hence, the present investigation was carried out to study the influence of different concentrations of spentwash on the nutrients of ginger (*Zingiber officinale*) and turmeric (*Curcuma longa)* of medicinal plants in normal and spentwash treated soils.

MATERIALS AND METHODS

Physicochemical parameters and amount of nitrogen (N), potassium (K), phosphorus (P) and sulphur (S) present in the primary treated spentwash and 33% spentwash were analysed by standard methods (Table 1). 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. Composite soil samples from both plots were collected at 25 cm depth, air-dried, powdered and analysed for physicochemical properties (Table 3).

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 phosphorus[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

The medicinal plants selected for the present investigation were ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*). 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 depending upon the climatic condition. At the maturity time, plants were harvested and proximate principles, vitamins, minerals and trace elements were analysed. Cultivation of plants was repeated for three times in each case, nutrients were analysed and average values were recorded (Table 4).

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), settleable solids (SS), chemical oxygen demand (COD), biochemical oxygen demand (BOD), carbonates, bicarbonates, total phosphorus (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 analysed (Table 1). Amounts of N, P, K and S contents are presented in Table 2.

Characteristics of experimental soils (Plot-1 & Plot-2) such as pH, electrical conductivity, amount of organic carbon, available nitrogen (N), phosphorus (P), potassium (K), sulphur (S), exchangeable calcium (Ca), magnesium (Mg), sodium (Na), DTPA iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) were analysed (Piper 1966, Black 1965, Jackson 1973) and given in Table 3.

The proximate principles, vitamins, minerals and trace elements of both plants were very good in 33% spentwash as compared to raw water irrigations in both the fields (Plots 1 & 2). However,

Table 4: Nutritive values of ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) in Plot-1 and Plot-2.

Parameters	Plot-1		Plot-2	
	RW	33% PTSW	RW	33% PTSW
Zingiber officinale				
Moisture[a]	80.90	80.80	80.90	80.90
Fat[a]	0.90	1.10	1.11	1.14
Acid insoluble ash[a]	0.3	0.35	0.3	0.3
Protein[a]	2.9	3.0	3.1	3.4
Fibre[a]	2.40	2.90	2.7	3.7
Carbohydrate[a]	12.65	14.2	13.8	14.2
Energy[b]	68.0	72.0	78.0	82.6
Calcium[c]	20.0	26.0	24.0	28.2
Magnesium[c]	400.0	428.0	410.0	432.2
Sodium[c]	1.0	1.60	1.4	1.9
Potassium[c]	0.20	0.34	0.28	0.42
Iron[c]	3.5	4.0	3.9	4.8
Phosphorus[c]	60.0	70.4	63.2	76.4
Zinc[c]	1.92	1.98	1.96	1.98
Manganese[c]	5.57	6.0	5.7	6.6
Copper[c]	0.73	0.87	0.80	0.90
Chlorides[c]	0.1	0.1	0.1	0.1
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]	0.2	0.2	0.2	0.2
Carotene[d]	40.0	45.0	42.0	48,6
Vitamin C[c]	6.0	8.0	7.0	9.0
Curcuma longa				
Moisture[a]	13.1	12.7	13.0	12.5
Fat[a]	5.2	5.6	5.4	6.0
Acid insoluble Ash[a]	0.25	0.26	0.26	0.27
Protein[a]	6.3	6.8	6.4	7.3
Fibre[a]	2.9	3.4	3.2	4.2
Carbohydrate[a]	69.4	74.8	73.4	78.9
Energy[b]	355.0	369.9	360.0	375.0
Calcium[c]	150.0	155.0	153.0	160.0
Magnesium[c]	278.0	288.0	325.0	356.0
Sodium[c]	86.2	88.2	87.8	90.0
Potassium[c]	130.0	170.0	150.0	176.0
Iron[c]	67.8	71.8	69.6	74.6
Phosphorous[c]	283.0	290.0	286.0	298.0
Zinc[c]	2.8	2.9	2.9	3.1
Manganese[c]	8.4	8.5	8.6	8.9
Copper[c]	0.39	0.40	0.40	0.42
Chlorides[c]	30.0	35.0	32.0	39.0
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]	38.0	45.0	40.0	48.0
Carotene[d]	30.0	45.0	36.0	48.0
Vitamin C[c]	0.001	0.001	0.001	0.001

a - g; b - kcal; **c** - mg; d - µg; RW - Raw water; PTSW - Primary treated spentwash; Plot-1: Normal soil; Plot-2: Spentwash treated soil nutrients uptake were high in Plot-2 than Plot-1 in all types of irrigations for both the plants and there was no negative impact of spentwash on the nutrients.

CONCLUSION

It was noticed that the uptake of nutrients of ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) was 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 phosphorus. It further concludes that the subsequent use of diluted spentwash for irrigation enriches the soil fertility and hence the diluted spentwash (33%) is effective ecofriendly irrigation medium for cultivation of ginger and turmeric without any adverse effect.

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REFERENCES

Amar, B.S., Ashisk, B.and Sivakoti, R. 2003. Effect of distillery effluent on plant and soil enzymatic activities and ground nut quality. Journal of Plant Nutrition and Soil Science, 166**:** 345-347**.**

Basavaraju, H.C. and Chandraju, S. 2008. Impact of distillery spent wash on the nutrients of leaves vegetables: An investigation. Asian J. of Chem**.,** 20(7): 5301-5310.

Basavaraju, H.C. and Chandraju, S. 2008. An investigation of impact of distillery spentwash on the nutrients of top vegetables. Internat. J. Agric. Sci., 4(2): 691-696.

Black, C.A. (Ed.) 1965. Methods of Soil Analysis. American Soc. of Agronomy.

Chares, S. 1985. Vinasse in the fertilization of sugarcane. Sugarcane, 1**:** 20.

Chandraju, S. and Basavaraju, H.C. 2007. Impact of distillery spent wash on seed germination and growth of leaves vegetables: An investigation. Sugar Journal (SISSTA), 38: 20-50.

Chandraju, S., Basavaraju, H.C.and Chidankumar, C.S. 2008. Investigation of impact of irrigation of distillery spent wash on the nutrients of cabbage and mint leaf. Indian Sugar, 19-28.

Chandraju, S., Basavaraju, H.C.and Chidankumar, C.S. 2008. Investigation of impact of irrigation of distillery spent wash on the nutrients of pulses. Asian J. Chem., 20(8): 6342-6348.

Chidankumar, C.S. and Chandraju, S. 2008. Impact of distillery spentwash irrigation on the nutrients of pulses in untreated and treated soil. Sugar Tech., 10(4): 314-318.

Deverajan, L. and Oblisami, G. 1995. Effect of distillery effluent on soil fertility status, yield and quality of rice. Madras Agricultural Journal, 82: 664-665**.**

Devarajan, L., Rajanna, G. Ramanathan, G. and Oblisami, G. 1994. Performance of field crops under distillery effluent irrigations, Kisan World, 21**:** 48-50.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice-Hall, London.

Joshi., H.C., Kalra, N. Chaudhary, A. and Deb, D.L. 1994. Environmental issues related with distillery effluent utilization in agriculture in India. Asia Pac. J. Environ. Develop., 1: 92-103.

Kaushik, K., Nisha, R., Jagjeeta, K., and Kaushik, C.P. 2005. 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.

Kuntal, M.H., Ashis, K., Biswas, A.K. and Misra, K. 2004. 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.

Mohamed Haroon, A.R. and Subash Chandra Bose, M. 2004. Use of distillery spentwash for alkali soil reclamation, treated distillery effluent for ferti irrigation of crops. Indian Farm., March, 48-51.

Patil, J.D., Arabatti, S.V. and Hapse, D.G. 1987. A review of some aspects of distillery spent wash (vinase) utilization in sugar cane. Bartiya Sugar, May**,** 9-15.

Pathak, H., Joshi, H.C., Chaudhary, A., Chaudhary, R., Kalra, N. and Dwivedi, M.K. 1998. Distillery effluent as soil amendment for wheat and rice. Journal of Indian Society for Soil Science, 46: 155-157**.**

Piper, C.S. 1966. Soil and Plant Analysis. University of Aidelade, Australia.

Pujar., S. S. 1995. Effect of Distillery Effluent Irrigation on Growth, Yield and Quality of Crops. M.Sc.(Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Ramadurai, R. and Gearard, E.J. 1994. Distillery effluent and downstream Products. SISSTA, Sugar Journal, 20: 129-131.

Raverkar, K.P., Ramana, S., Singh, A.B., Biswas, A.K. and Kundu, S. 2000. 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.

Ramana, S. Biswas, A.K., Kundu, S., Saha, J.K. and Yadava, R.B.R. 2001. Effect of distillery effluent on seed germination in some vegetable crops. Bioresource Technology, 82(3): 273-275.

Rani, R. and Srivastava, M.M. 1990. Eco-physiological response of *Pisum sativum* and *Citrus maxima* to distillery effluents. Int. J. of Ecology and Environ. Science, 16-23.

Rajendran, K. 1990. Effect of distillery effluent on the seed germination, seedling growth, chlorophyll content and mitosis in *Helianthus annuus*. Indian Botanical Contactor, 7: 139-144.

Ramana, S., Biswas, A.K., Kundu, S., Saha, J.K. and Yadava, R.B.R. 2000. Physiological response of soybean (*Glycine max* L.) to foliar application of distillery effluent. Plant Soil Research, 2: 1-6.

Singh, Y. and Raj Bahadur 1998. Effect of application of distillery effluent on maize crop and soil properties. Indian J. Agri. Science., 68: 70-74.

Sahai, R., Jabeen, S. and Saxena, P.K. 1983. Effect of distillery waste on seed germination, seedling growth and pigment content of rice. Indian Journal of Ecology, 10: 7-10.

Samuel, G. 1986. The use of alcohol distillery waste as a fertilizer. Proceedings of International American Sugarcane Seminar, 245-252.

Zalawadia, N.M., Ramana, S. and Patil, R.G. 1997. 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.