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Impact of Distillery Spentwash on the Nutrients of Leaves Vegetables: An Investigation

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A field experiment was conducted during summer season Dec-2006 to study the impact of distillery spentwash on the nutrients of different leaves vegetables. The distillery spentwash *i.e.*, primary treated spentwash (PTSW), 50 and 33 % distillery spentwash were analyzed for their physical and chemical parameters. Experimental soil was tested for its chemical and physical parameters. The leaves vegetable seeds (Nanadhari and Mayhco) were sowed in the prepared land dimension of 3' × 4' blocks. Seeds were irrigated by using raw water (RW), 50 and 33 % distillery spentwash. The impact of distillery spentwash on proximate principles (moisture, protein, fat, fibre, carbohydrate, energy, calcium, phosphorous and iron), vitamin content (carotene and vitamin C), mineral and trace elements (magnesium, sodium, potassium, copper, manganese, zinc, chromium and nickel) were studied.

Key Words: Distillery spentwash, Leaves vegetables, Nutrients, Proximate principles.

INTRODUCTION

Molasses (one of the important byproducts of sugar industry) is the chief source for the production of alcohol in distilleries. They produce about 40 billion litres of wastewater known as raw spentwash (RSW), which is characterized by high biological oxygen demand (BOD: 5000-8000 mg/L) and chemical oxygen demand (COD: 25000-30000 mg/L)[1]. Raw spentwash is normally discharged into open land or near by water bodies resulting in a number of environmental problems including threat to plant and animal lives. The RSW is highly acidic and containing easily oxidizable organic matter with very high BOD and COD[2]. Distillery spentwash contains highest content of organic nitrogen and nutrients[3]. By installing biomethenation plant in distilleries, reduce the oxygen demand of RSW. The resulting spentwash obtained is called primary treated spentwash (PTSW) and primary treatment to RSW increases the nitrogen, potassium and phosphorous contents

and decreases the calcium, magnesium, sodium, chloride and sulphate[4]. The PTSW is rich in potassium, sulphur, nitrogen, phosphorous as well as easily biodegradable organic matter and its application to soil has been reported to be beneficial to increase sugar cane[5], rice[6], wheet and rice yeild[7] and ground nut quality[8] and physiological response of soyabean[9]. Diluted distillery spentwash could be used for irrigation purpose without adversely affecting soil fertility[10,12] and seed germination and crop productivity[13]. The diluted effluent irrigation improved the physical and chemical properties of the soil and further increased soil microflora[10,11,14]. Twelve pre-sowing irrigations with the diluted distillery spentwash had no adverse effect on the germination of maize but improved the growth and yield[15]. Diluted distillery spentwash increases the growth of peas found that shoot length, leaf number per plant, leaf area, chlorophyll content[16]. Increased concentration of distillery spentwash in diluted distillery spentwash causes decreased seed germination, seedling growth and chlorophyll content in sunflowers (*Helianthus annuus*) and the distillery spentwash could safely used for irrigation purpose at low concentration of distillery spentwash[13,17]. The distillery spentwash contained an excess of various forms of cations and anions, which are injurious to plant growth. The concentration of these constituents should be reduced to beneficial level by diluting the spentwash, which can be used as a substitute for chemical fertilizer[18]. The distillery spentwash could be used as a complement to mineral fertilizer to sugarcane[19]. The distillery spentwash contained N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation water[20]. The application of diluted distillery 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[21]. Mineralizations of organic material as well as nutrients present in the distillery effluent were responsible for increased availability of plant nutrients[22]. However, not much information is available on the impact of distillery spentwash on the nutrients of leaves vegetables. Therefore, the present investigation is carried out to study the impact of different concentration of distillery spentwash on the plant nutrients of leaves vegetables.

EXPERIMENTAL

The field work was conducted during Dec-2006 at the field of Chamundi Distilleries Pvt. Ltd. Before initiation of the experiment, a composite soil sample was collected from the experimental site at 25 cm depth. The soil sample was air dried, powdered and analyzed for physico-chemical properties using standard procedures (Table-1). The PTSW was used for the irrigation with suitable dilution *i.e.*, 50 and 33 %. The PTSW, 50 and 33 % spentwash

TABLE-1
CHARACTERISTICS OF EXPERIMENTAL SOIL

Parameters	Units	Sample values
Coarse sand	%	9.72
Fine sand	%	40.80
Slit	%	25.28
Clay	%	24.20
pH value (1:2 solution)	–	8.16
Organic carbon	%	0.61
Electrical conductivity	μS	526
Available Nitrogen	ppm	340
Available Phosphorous	ppm	130
Available Potassium	ppm	80
Exchangeable Calcium	ppm	140
Exchangeable Magnesium	ppm	220
Exchangeable Sodium	ppm	90
Available Sulphur	ppm	240
DTPA Iron	ppm	200
DTPA Manganese	ppm	220
DTPA Copper	ppm	5
DTPA Zinc	ppm	50

were collected from Chamundi Distilleries Pvt. Ltd. at Maliyur, Mysore District. The physical and chemical parameters and amount of nitrogen, potassium, phosphorous and sulphur present in the PTSW, 50 and 33 % distillery spentwash were analyzed using standard procedures (Tables 2 and 3). The leaves vegetable seeds selected for field experiment are Amaranth (*Amaranthus gangeticus*), Coriander leaves (*Coriandum sativum*), Fenugreek (*Trigonella foenum graceum*), Shepu (*Peucedanum graveolens*) and Spinach (*Spinacia oleracea*). The leaves vegetable seeds were sowed in the prepared block field and irrigated with raw water, 50 and 33 % distillery spentwash at the dosage of twice in a week and rest of the period with raw water. The leaves vegetable plant were harvested at the time of maturity and proximate principles, vitamins, minerals and trace elements present in the plants were analyzed (Tables 4-8).

RESULTS AND DISCUSSION

Table-1 shows the characteristics of experimental soil *i.e.*, pH, electrical conductivity, the amount of organic carbon, available nitrogen, phosphorous, potassium, sulphur exchangeable calcium, magnesium, sodium, DTPA iron, manganese, copper and zinc.

TABLE-2
CHEMICAL COMPOSITION OF THE DISTILLERY SPENTWASH

Chemical parameters	Units	PTSW	50 % SW	33 % SW
pH	–	7.65	7.73	7.75
Electrical conductivity	µS	28800	19660	10020
Total solids	mg/L	46140	26170	20870
Total dissolved solids	mg/L	35160	16060	10140
Total suspended solids	mg/L	10540	5680	4380
Settleable solids	mg/L	10070	4340	3010
COD	mg/L	40530	18316	10228
BOD	mg/L	16200	7818	4800
Carbonate	mg/L	Nil	Nil	Nil
Bicarbonate	mg/L	13100	7400	4200
Total phosphorous	mg/L	30.26	12.20	6.79
Total potassium	mg/L	7200	3700	2400
Calcium	mg/L	940	600.0	380.0
Magnesium	mg/L	1652.16	884.16	542.22
Sulphur	mg/L	74.8	35.0	22.6
Sodium	mg/L	480	260	240
Chlorides	mg/L	5964	3272	3164
Iron	mg/L	9.2	6.40	5.20
Manganese	mg/L	1424	724	368
Zinc	mg/L	1.28	0.72	0.41
Copper	mg/L	0.276	0.134	0.074
Cadmium	mg/L	0.039	0.021	0.010
Lead	mg/L	0.16	0.09	0.06
Chromium	mg/L	0.066	0.032	0.014
Nickel	mg/L	0.165	0.084	0.040
Ammonical nitrogen	mg/L	743.68	345.24	276.64

PTSW = Primary treated distillery spentwash.
50 % SW = 50 % distillery spentwash.
33 % SW = 33 % distillery spentwash.

TABLE-3
AMOUNT OF N, P, K AND S (NUTRIENTS) IN
DISTILLERY SPENTWASH

Chemical parameters	Units	PTSW	50 % SW	33 % SW
Ammonical nitrogen	mg/L	743.68	345.24	276.64
Total phosphorous	mg/L	30.26	12.20	6.79
Total potassium	mg/L	7200	3700	2400
Sulphur	mg/L	74.8	35.0	22.6

PTSW = Primary treated distillery spentwash.
50 % SW = 50 % distillery spentwash.
33 % SW = 33 % distillery spentwash.

TABLE-4
AMOUNT OF PARAMETERS AT DIFFERENT IRRIGATION SYSTEM IN 100 g OF EDIBLE PORTION OF AMARANTH
(*Amaranthus gangeticus*)

Parameters	Units	Results		
		RW	50 % SW	33 % SW
Moisture	g	85.9	86.4	86.9
Fat	g	0.2	0.3	0.35
Acid insoluble ash	g	0.05	0.04	0.04
Protein	g	3.9	4.2	4.5
Fibre	g	0.8	1.2	1.25
Carbohydrate	g	5.4	5.6	6.0
Energy	kcal	42	48	50
Calcium	mg	380	375	400
Magnesium	mg	110	115	120
Sodium	mg	200	240	250
Potassium	mg	320	335	340
Iron	mg	3.0	3.1	3.2
Phosphorous	mg	75	79	84
Zinc	mg	0.12	0.15	0.16
Manganese	mg	0.25	0.3	0.35
Copper	mg	0.04	0.06	0.066
Chlorides	mg	70	75	84
Lead	mg	Nil	Nil	Nil
Cadmium	mg	Nil	Nil	Nil
Chromium	mg	0.006	0.007	0.007
Nickel	mg	Nil	Nil	Nil
Sulphur	mg	40	45	62
Carotene	μg	5200	5250	5255
Vitamin C	mg	80	82	85

RW = Raw water.
50 % SW = 50 % distillery spentwash.
33 % SW = 33 % distillery spentwash.

Table-2 shows the chemical composition of PTSW, 50 % SW and 33 % SW *i.e.*, pH value, 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, total potassium, ammonical nitrogen, calcium, magnesium, sulphur, sodium, chlorides, iron, manganese, zinc, copper, cadmium, lead, chromium and nickel and also indicating the changes in parameters of PTSW, 50 % SW and 33 % SW. Table-3 shows the amount of N, P, K and S content in PTSW, 50 % SW and 33 % SW.

TABLE-5
AMOUNT OF PARAMETERS AT DIFFERENT IRRIGATION SYSTEM IN 100 g OF EDIBLE PORTION OF CORIANDER LEAVES (*Coriandum sativum*)

Parameters	Units	Results		
		RW	50 % SW	33 % SW
Moisture	g	86.4	86.8	87.1
Fat	g	0.5	0.7	0.7
Acid insoluble ash	g	0.32	0.35	0.39
Protein	g	3.5	3.7	3.8
Fibre	g	1.5	1.8	1.85
Carbohydrate	g	5.4	5.6	5.9
Energy	kcal	38	40	43
Calcium	mg	190	196	199
Magnesium	mg	25	28	29
Sodium	mg	52	60	64
Potassium	mg	280	285	290
Iron	mg	1.3	1.5	1.52
Phosphorous	mg	60	68	70.5
Zinc	mg	0.25	0.30	0.32
Manganese	mg	0.40	0.42	0.44
Copper	mg	0.08	0.10	0.12
Chlorides	mg	35	40	42
Lead	mg	Nil	Nil	Nil
Cadmium	mg	Nil	Nil	Nil
Chromium	mg	0.006	0.016	0.017
Nickel	mg	Nil	Nil	Nil
Sulphur	mg	25	35	37
Carotene	µg	6210	6250	6255
Vitamin C	mg	120	125	128

RW = Raw water.
50 % SW = 50 % distillery spentwash.
33 % SW = 33 % distillery spentwash.

Table-4 indicates the impact of distillery spentwash on the nutrients of Amaranth (*Amaranthus gangeticus*) leaves vegetable. All the parameters except calcium, it was found that the increased uptake in the case of both 50 and 33 % spentwash as compared to raw water. There was no impact of heavy metals like lead, cadmium and nickel on Amaranth leaves vegetable. However, remarkable uptake of all the nutrients in the case of 33 % spentwash was noticed.

Table-5 gives the impact of distillery spentwash on the nutrients of Coriander (*Coriandum sativum*) leaves vegetable. There was no negative impact of spent wash on the nutrients of Coriander leaves and heavy metals

TABLE-6
AMOUNT OF PARAMETERS AT DIFFERENT IRRIGATION SYSTEM IN 100 g OF EDIBLE PORTION OF FENUGREEK
(*Trigonella foenum graceum*)

Parameters	Units	Results		
		RW	50 % SW	33 % SW
Moisture	g	86.2	86.4	86.6
Fat	g	0.4	0.6	0.6
Acid insoluble ash	g	0.03	0.03	0.03
Protein	g	4.0	4.8	4.9
Fibre	g	0.8	0.9	0.98
Carbohydrate	g	5.1	5.4	6.0
Energy	kcal	40	42	45
Calcium	mg	380	390	400
Magnesium	mg	20	24	30
Sodium	mg	60	62	75
Potassium	mg	20	22	25
Iron	mg	1.4	1.8	1.85
Phosphorous	mg	40	45	50
Zinc	mg	0.25	0.29	0.30
Manganese	mg	0.15	0.18	0.20
Copper	mg	0.08	0.1	0.16
Chlorides	mg	140	145	150
Lead	mg	Nil	Nil	Nil
Cadmium	mg	Nil	Nil	Nil
Chromium	mg	0.006	0.016	0.017
Nickel	mg	Nil	Nil	Nil
Sulphur	mg	150	160	166
Carotene	µg	2420	2500	2550
Vitamin C	mg	40	45	50

RW = Raw water.
50 % SW = 50 % distillery spentwash.
33 % SW = 33 % distillery spentwash.

like lead, cadmium and nickel. A very good uptake of all the parameters in both 50 and 33 % spentwash as compared to raw water, but all the parameters are very good in 33 % distillery spentwash.

Table-6 shows the impact of distillery spentwash on the nutrients of Fenugreek (*Trigonella foenum graceum*) leaves vegetable. Both 50 and 33 % spentwash gives a good nutrients intake as compared to raw water. However uptakes of all the nutrients are considerably good in the case of 33 % spent wash than 50 % spentwash.

Table-7 indicates the impact of distillery spentwash on the nutrients of Shepu (*Peucedanum graveolens*) leaves vegetable. A very poor intake of the nutrients like calcium, magnesium, sodium, potassium and iron in the

TABLE-7
AMOUNT OF PARAMETERS AT DIFFERENT IRRIGATION SYSTEM IN 100 g OF EDIBLE PORTION OF SHEPU (*Peucedanum graveolens*)

Parameters	Units	Results		
		RW	50 % SW	33 % SW
Moisture	g	88.2	88.5	88.8
Fat	g	0.3	0.2	0.3
Acid insoluble ash	g	0.02	0.03	0.03
Protein	g	4.0	4.2	4.8
Fibre	g	1.2	1.4	1.47
Carbohydrate	g	4.9	5.5	5.8
Energy	kcal	38	45	50
Calcium	mg	340	330	370
Magnesium	mg	105	90	110
Sodium	mg	180	170	183
Potassium	mg	280	270	300
Iron	mg	25	22	28
Phosphorous	mg	40	45	60
Zinc	mg	0.10	0.12	0.15
Manganese	mg	0.2	0.3	0.35
Copper	mg	0.02	0.02	0.03
Chlorides	mg	60	62	65
Lead	mg	Nil	Nil	Nil
Cadmium	mg	Nil	Nil	Nil
Chromium	mg	Nil	Nil	Nil
Nickel	mg	Nil	Nil	Nil
Sulphur	mg	48	55	58
Carotene	µg	1300	1380	1400
Vitamin C	mg	80	85	90

RW = Raw water.
50 % SW = 50 % distillery spentwash.
33 % SW = 33 % distillery spentwash.

case of 50 % distillery spentwash as compared to raw water and 33 % distillery spentwash. But very good intake of carotene and vitamin C in both the cases of spentwash than raw water. In the case of Shepu leaves vegetable, all the nutrients are very good in the case of 33 % spentwash.

According to Table-8, in the case of Spinach (*Spinacia oleracea*) leaves vegetable the intake of the parameters, protein, fibre, carbohydrate and energy are similar in the case of raw water and 50 % spentwash and the nutrients, calcium, magnesium, sodium, potassium, iron, phosphorous, copper, carotene and vitamin intake was very poor in the case of 50 % spentwash as compared to raw water and 33 % spentwash. However, intakes of all the parameters are very good in the case of 33 % spentwash than 50 % spentwash.

TABLE-8
AMOUNT OF PARAMETERS AT DIFFERENT IRRIGATION SYSTEM IN 100 g OF EDIBLE PORTION OF SPINACH (*Spinacia oleracea*)

Parameters	Units	Results		
		RW	50 % SW	33 % SW
Moisture	g	93.5	93.7	93.8
Fat	g	0.4	0.4	0.5
Acid insoluble ash	g	0.35	0.32	0.34
Protein	g	1.8	1.8	2.0
Fibre	g	0.2	0.2	0.26
Carbohydrate	g	2.3	2.2	2.4
Energy	kcal	20	20	22
Calcium	mg	65	62	66
Magnesium	mg	65	60	65
Sodium	mg	52	50	55
Potassium	mg	185	180	195
Iron	mg	1.0	0.9	1.02
Phosphorous	mg	16	15	18
Zinc	mg	0.25	0.25	0.30
Manganese	mg	0.40	0.40	0.49
Copper	mg	0.09	0.08	0.10
Chlorides	mg	45	40	45
Lead	mg	Nil	Nil	Nil
Cadmium	mg	Nil	Nil	Nil
Chromium	mg	0.001	0.004	0.004
Nickel	mg	Nil	Nil	Nil
Sulphur	mg	25	25	32
Carotene	µg	5300	5200	5400
Vitamin C	mg	25	22	26

RW = Raw water.
50 % SW = 50 % distillery spentwash.
33 % SW = 33 % distillery spentwash.

Conclusion

Among the irrigation with 33 and 50 % distillery spentwash and raw water for the above mentioned leaves vegetables, it concludes that, the intake of all nutrients are very good in both 50 and 33 % spentwash except in the case of Shepu and Spinach as compared to raw water. There was a good response in the improvement of nutrients in cultivation of all types of leaves vegetables in 33 % spentwash than 50 % spentwash and raw water. Also it concludes that, the diluted spentwash (33 %) is good for the cultivation of leaves vegetable plants.

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