Assessment of quality of soil using treated spent wash of distillery by cation exchangers from agricultural waste i.e wheat-straw.

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ABSTRACT

Due to discharge of untreated industrial effluents from various industries changes the chemical properties of soil and effect on the food chain as well as on human health. Distillery spent wash have very high value of organic matter, total solids, suspended solids, COD, BOD, nitrogen contents, phosphorous and heavy metal ions which had changed the Physico- chemical properties of the soil. Soil irrigated with untreated distillery effluent also had higher availability of N, P, Na, and K in the both layers of soil. Concentration of heavy metals was found higher in surface layer than the sub surface layer of soil. All the value of heavy metals Cr, Cu, Mn, Fe, Pb and Zn were above the permissible limit in both layers of soils. The Physico- chemical properties of the soil improved by using treated distillery effluent with cation- exchanger from wheat- straw. The pH of the soil in a pilot plot improved by using treated distillery mill effluent in different dilutions. The electrical conductivity was also improved. Organic carbon content reduced and toxicity of sodium ion was also reduced. Potassium content improved in the soil which is very essential for saline alkaline soil. The nitrogen present in the soil is converted into ammonia which will help to improve fertility of the soil. Heavy metals in the soil were in the permissible limit with different dilution of treated effluent of distillery mill. Few dilutions of treated distillery effluent can be used for irrigation (60ml treated effluent+40 ml water) and (40 ml of treated effluent + 60 ml of water). Present studies showed that high concentration of heavy metal ions was significantly reduced which affect adversely on the growth of plants as well as human health.

Keywords: S.W.S, BOD, COD, DO

INTRODUCTION

Due to increasing Industrialization, effluents discharged from the different industries effect on the health of soil as well as pollute the various water bodies. Effluent discharged from the various distilleries without any recommended treatment can pose serious environmental impact in the nearby water bodies as well as on land (1-2). Distillery effluent is in rich with high organic carbon content along with high contents of N, P and K. The use of untreated waste water from distillery industry leads to deterioration of soil physical, chemical, and biological properties. Various distilleries discharge gallons of waste water which is highly colored and having many toxicants above the permissible limits. Distillery effluent is categorized as one of the most polluting effluents. Continuous use of untreated spent wash by farmers for crop production can cause serious threat to human health. The accumulation of heavy metal ions on the soil present due to discharge of spent wash of distillery mill will affect the quality of soil seriously. These metal ions accumulate from the soil in the various vegetables may cause various diseases like Itai-Itai, Minamata, bronchial asthma etc. They may affect on kidney, liver, lungs, brain and reproductive systems. Yamuna Nagar is the second biggest industrial town in Haryana, India. There are more than 2500 industries are established. Long scale industries like Paper mill, Sugar mill, Starch mill and Distillery mill discharged their waste water without any recommended treatment in to nearby water bodies as well as on land which are affected seriously the quality of water and soil in this area. The spent wash of distillery is much polluted therefore it is very essential to adopt various measures such as recycling of waste water, evaporation process, use various secondary treatment process to use this huge amount of waste water for irrigation purposes. Duval (3) had successfully pretreated distillery spent wash by centrifugation and flocculation method. Kato (4) used reverse osmosis process to treat distillery waste and recycled it. Dubey (5) reported the spent wash can be treated by electro- flocculation with the addition of 6.5percent sodium chloride to the waste water with a pH from 3.8 to 7 and temperature from 49 degree centigrade to 82 degree centigrade. Schropffer (6) achieved 70- 75 percent reduction in BOD by anaerobic contact process. Boopathy and Tikhe(7) used hybrid anaerobic baffled reactors to treat high strength molasses and obtained 70 percent reduction at an organic loading rate. Amal Raj et al (8) used up flow anaerobic filter in the treatment of distillery spent wash. Kapadnis et al (9) used hydrogen peroxide, calcium oxide and soil bacteria to

remove BOD and color from distillery waste. Gokarn et al (10) used Moringa oleifera seeds for removing color from distillery spent wash. Ramteke et al (11) used pyro- char from waste sludge of paper mill for the removal of color and reduction of COD from spent wash od distillery. Deepak Kumar et al (12) studied the decolorizing of distillery spent wash with cation exchanger indigenously prepared from the agricultural waste wheat straw.

Ion exchangers are large molecular weight insoluble polyelectrolyte's having cross linked structure which contains ionic groups. Ion exchangers can be prepared from synthetic materials as well as from natural sources like coal, wood, paper, leaves, grasses, rice husk (13-15) and wheat- straw. Conversion of wheat- straw in to cation exchanger and used it for the treatment of spent wash of distillery and then used that treated effluent for improving the quality of soil is a meaningful proposition. The distillery spent wash has high value of COD, BOD, low pH, high acidity, dark color, high organic contents, high percentage of inorganic contents (16-17). Distillery mill waste water also contains nutrients in the form of N, P, K along with heavy metal ions which affect the soil quality very seriously. Soil treated with different dilution of treated spent wash with cation exchanger from wheat straw improved to quite extent. Therefore, cation exchanger made from agricultural waste is a strong alternative for the removal of heavy metals and other pollutants from the effected soil with untreated effluent. In view of this, the present study was undertaken to analyze the Physico- chemical properties of spent wash from distillery mill in Yamuna Nagar, Haryana, India, and its impact on the Physico- chemical properties of soil in the nearby area. The study was undertaken to treat spent wash with cation exchanger from wheat- straw and then used that treated water in different dilution to improve the quality of soil in that area.

2 Material and Methods

2.1 Physico- chemical Studies of Spent wash from Distillery.

The samples of spent wash of distillery mill located in Yamuna Nagar, Haryana, India were collected and various Physico-chemical studies i.e. pH, total solids, dissolved solids, suspended solids, chloride contents, DO, BOD, COD, Calcium and Magnesium ions and chloride contents were undertaken by using the standard methods of water analysis (18) shown in table (1-2).

2.2 Physico-chemical studies of soil samples where spent wash discharged directly on land.

Soil samples of surface soil (0-15cm) and sub surface soil (15-30cm) were collected from spent wash irrigated fields in different seasons. The soil samples were air dried ground with the help of wooden pestle mortar and then pass through 2 mm mesh sieve, after mixing thoroughly stored in a polythene bag and analyzed by using standard methods of soil analysis (19). The various parameters were studied are i.e., pH, electrical conductance, total phosphorous, nitrogen, potassium, and sodium (20). DTPA extraction methods were used to evaluate number of heavy metals with the help of atomic absorption spectrophotometer (21). The results were shown in table (3-4).

2.3 Treatment of spent wash with indigenously prepared cation- exchanger from wheat-straw.

Chromatography columns were packed with newly formed cation- exchanger from wheat-straw and diluted spent wash pass through these exchangers. The Physico- chemical studies of spent wash after passing through these columns were again determined by following the same parameters and same standard methods for water analysis.

2.4 Effect of Treated Spent washes with Cation- exchangers from Wheat- straw on the Physico- chemical properties of soil.

Treated spent wash of distillery mill with S.W.S was used for irrigation purpose in a pilot plot. Irrigation with treated spent wash after varying dilution was undertaken. Changes in the Physico- chemical properties of soil irrigated with treated spent wash in both layers of the soil were studied by using standard methods of soil testing.

Result and Discussion

Conversion of wheat-straw in to cation- exchangers is an indigenous approach for recycling of agricultural waste. Spent wash of distillery industry is a dark brown color waste having higher soluble salts which makes it unsuitable for direct disposal on land. The exchange capacity of H+ forms of cation- exchangers from wheat- straw is very good which is very much suitable for the reduction in various Physico- chemical parameters of waste water such as pH, total solids, dissolved solids, suspended solids, electrical conductance, alkalinity, acidity, free CO_2, hardness, total chloride contents, COD, BOD, DO and various metal ions like Cr, Cd, Cu, Zn and Mn. The Physico- chemical studies of distillery spent wash without treatment and after treatment with cation – exchangers were shown in tables (1-2). The pH of the effluent ranges from 3.43- 4.2mgL-1 in different seasons as shown in table (1). The composition of BOD 14642-15948 mgL-1, COD 104800-114400mgL-1, total solids 82468 to 85000 mg-L-1, dissolved solids 65740-68246mgL-1, suspended solids 16136-16754mgL-1, chloride contents 3246-3408mgL-1, Ca^{2}+ ion 2260-2842mgL-1,

Mg^{2}+ ion 1248-1638mgL-1, total nitrogen 1500-1780mgL-1 and heavy metals Cr^{6}+, Cu^{2}+, Mn^{2}+, Zn^{2}+ in the range 324-365mgL-1, 28.4-58.7mgL-1, 1484-1864mgL-1 and 8.90-10.20mgL-1 in different seasons shown in table (1).

Waste water from distillery mill showed considerable reduction in various Physico-chemical parameters after treatment with S.W.S cation exchangers. The reduction in BOD and COD was 34.27 percent and 34.6 percent but hardness reduced up to 60.56 percent and suspended solids reduced up to 78.09 percent shown in table (2). There was considerable reduction in heavy metal ions concentration in the effluent. Cr^{6}+ shows 27.12 percent reduction, Cu^{2}+ 65.58 percent reduction, Zn^{2}+ 33.33 percent and Mn^{2}+ 41.53 percent reduction showed in table (2).

This cation -exchangers reduced the pollution load of distillery spent wash to such an extent that it can be successfully used for irrigation purposes or may be discharged it into any water bodies shown in table (2). Use of treated spent wash help to improve the quality of soil in terms of Carbon contents, Nitrogen contents, Phosphorous contents, pH value of soil, potassium contents and sodium contents. Heavy metals in the soils were found in the permissible limit after irrigation with different dilution of treated effluent with S.W.S. Few dilutions of treated distillery spent wash (60ml treated effluent+ 40 ml water) and (40 ml of distillery treated effluent + 60 ml water) can be successfully used for irrigation purposes, shown in table (5-6). Use of treated spent wash with S.W.S not only improved the soil quality but also increased the yields of crops at reduced cost and solves the problem of solid waste management. Treated spent wash is an excellent source of nutrients for cultivation which will help to reduce the use of chemical fertilizers.

Table—1

Physico-chemical studies of Distillery mill Effluent.

S.NO	Parameters	Summer	Monsoon	Winter	Mean
1	pH	3.97	4.2	3.43	3.8
2	DO	0.O	0.2	0.0	--
3	BOD	15948	14642	15006	15198
4	COD	114400	104800	109800	109666
5	Total Solids	85000	82468	84376	83498
6	Dissolved Solids	68246	65740	68240	67408
7	Suspended Solids	16754	16728	16136	16539
8	Chloride Contents	3408	3246	3298	3317
9	Calcium ions	2260	2842	2468	2523
10	Magnesium ions	1248	1638	1398	1428
11	Cr^{6}+	365	324	348	345
12	Cu^{2}+	58.7	28.4	32.6	39.9
13	Mn^{2}+	1748	1484	1864	1698
14	Zn^{2}+	10.20	8.90	9.95	9.68

Table—2

Treatment of Distillery Effluent with H^+ Form S.W.S

S.NO	Parameters	Untreated effluent	Treated effluent	% Reduction
1	pH	3.97	4.4	9.09
2	DO	0.0	1.8	--
3	BOD	15948	10482	34.29
4	COD	114400	74800	34.61
5	Total Solids	85000	52470	38.27
6	Dissolved Solids	68246	48800	28.49
7	Suspended Solids	16754	3670	78.09
8	Chloride contents	3408	2642	22.47
9	Calcium ions	2260	1642	27.34
10	Magnesium ions	1248	1068	14.42
11	$Cr^{6}+$	365	266	27.12
12	$Cu^{2}+$	58.7	20.2	65.58
13	$Zn^{2}+$	10.20	6.8	33.33
14	$Mn^{2}+$	1748	1022	41.53

Table-3 Effect of distillery spent wash from distillery industry on the Physico- chemical properties of soil in Yamuna Nagar area.

S. No	Parameters	S1	S2	S3	S4
1	pH	* 8.28 **8.02	7.9 7.7	8.0 7.8	7.82 7.5
2	Electrical conductivity (mscm-1)	*0.22 ** 0.20	0.52 0.46	0.38 0.33	0.46 0.39
3	Organic carbon (gkg-1)	*3.8 **3.2	5.8 5.2	7.71 6.47	6.91 6.24
4.	Available Na (kg ha-1)	*458 **482	396 424	298 366	428 478
5	Available K (kgha-1)	*672 **618	628 574	486 426	689 642
6	Nitrogen	*146 **126	118 109	126 114	122 108

*Soil sample from the surface layer (0-15cm)
**Soil sample from the sub surface layer (15-30cm)

Table—4

Heavy metals analysis of soil where distillery spent wash merges without treatment.

S.No	Site	Cr	Cu	Fe	Mn	Zn
1	S1*	1.402	6.64	39.46	32.46	6.786
	S1**	1.056	4.78	34.65	31.65	6.123
2	S2*	0.978	7.228	58.24	28.72	5.248
	S2**	0.803	7,005	53.29	25.88	4.876
3	S3*	0.864	5.746	33.04	21.24	3.480
	S3**	0.741	5.543	23.75	18.67	3.006
4	S4*	0.762	3.658	20.86	16.41	3.21
	S4**	0.579	3.142	23.78	14.87	3.04

*Soil sample from the surface layer (0-15cm)
**Soil sample from the sub surface layer (15-30cm)

Table—5

Physico- chemical properties of soil samples by irrigation with varying dilution of treated spent washof distillery mill with S.W.S.

S. No	Dilution	pH	EC	OC	Na	K	N
1	100 % treated spent wash with S.W.S	*7.86 **7.72	0.128 0.118	1.480 1.260	402 378	610 591	184 162
2	60ml+40ml Treated +Water effluent	*7.64 **7.42	0.108 0.096	1.280 1.091	410 367	524 517	176 164
3	40ml+60ml Effluent +Water	*7.52 **7.24	0.118 0.104	1.105 1.077	411 387	410 301	151 137
4	20ml+80ml Effluent + Water	*6.84 **6.62	0.126 0.108	0.980 0.751	384 361	378 315	130 116
5	10ml + 90ml Effluent + Water	*6.74 **6.71	0.118 0.100	1.110 1.005	388 380	364 355	128 118

*Treated soil sample from surface layer (0-15cm)

**Treated soil sample from sub surface layer (15-30cm)

Table—6

Heavy metals analysis of soil samples irrigated with diluted distillery effluent treated with S.W.S.

S. No	Dilution	Cr	Cu	Fe	Mn	Zn
1	100% treated effluent	*0.986 **0.742	2.74 1.98	18.92 17.37	8.265 8.198	2.748 2.462
2	60ml+40ml Effluent + Water	*0.842 **0.646	0.976 0.824	19.72 19.56	8.864 8.721	2.168 1.980
3	40ml + 60 ml Effluent + Water	*0.218 **0.176	0.624 0.620	14.46 14.10	9.646 9.156	1.642 1.689
4	20ml + 80ml Effluent + Water	*0.186 **0.154	0.728 0.764	11.26 10.81	9.784 9.865	1.542 1.446
5	10 ml + 90ml Effluent + Water	*0.246 **0.197	0.864 0.792	9.068 8.968	9.604 9.298	1.256 1.218

*Treated soil sample from surface layer (0-15cm)

**Treated soil sample from sub surface layer (15-30cm)

Conclusion

From the present study, it is evident that the soil of Yamuna Nagar is contaminated to great extent with heavy metals due to long term use of untreated effluent from distillery industry. Different crops absorbed and accumulates different toxic components to great extent which will enters the food chains and affect the people residing in this area. The accumulation of heavy metals and other toxicants in the soils (22) is an important issue and a challenge which will adversely affect on environment and treat to living organisms. Therefore, recycling and reuse of industrial effluents in agriculture is not only helpful for conserving the water for irrigation, but also the plant nutrients in the soils. Use of agricultural waste i.e., wheat-straw to produce cation-exchangers is a need of the hour and used of it in the treatment of distillery effluent and used of treated effluent on soil for irrigation is a very meaningful proposition which will not only improve the quality of soil but also effect on the growth of plants and improve the health of human beings.

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