Bio-composting of Distillery Waste to Control Water Pollution

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Abstract **:**

In a developing country like India, distillery industries have become a major source of pollution, as 88% of its raw materials are converted into waste and discharged into the water bodies, causing water pollution. The waste water from distilleries carry appreciable organic load. The spent wash is colored, highly acidic with very offensive odor, which poses serious environmental problems. To overcome it's ill effects and to reduce the cost of the effluent treatment, the present research has been undertaken to convert the distillery waste into compost by means of Biocomposting. The present work also includes the study of abiotic factors affecting the rate of decomposition and a few innovative works have been done to improve the quantity and quality of the Biocompost. Comparisons of the Bio-compost produced by this method with chemical fertilizers have been made and the results are encouraging.

I. INTRODUCTION

Rapid population growth in developing countries, compounded with industrial growth and unplanned urbanization forms one of the prime environmental concerns of the world. The matter becomes more complicated by the fact that such countries lack the necessary infrastructure to cope up with the resultant problems. One such area, where the fall-out of such environmental imbalances is most evident, is surface water. Bulk quantities of waste water generated from urban sprawls and various industrial sectors, containing pollutants, are drained into the sources of fresh water supplies, thereby threatening all life forms in those particular areas.

Distillery waste forms one of the major causes of water pollution in India. About 88% of the raw materials used by the distillery industry end as waste. In the current levels of production technology used by the Indian distilleries, approximately 13 to 15 litres of waste water is generated in the production of 1 litre of alchohol. Besides carrying appreciable organic load, spent wash is colored and highly acidic having odd smell and it also contains appreciable amount of dissolved organic and inorganic matter - all of which pose serious environmental problem. [1]. The brief constitution of the spent wash [6] is as referred in Table-1. If spent wash is discharged into a water stream, it may cause serious environmental problems affecting both water bodies and land.(Table 2)

Table -1-Physico chemical characteristics of spent wash from distillery

Sl.No	Parameter	Average
O1	pH	3.8-4.5
O2	Total Solids	6500-110000 mg/L
03	Total Suspended Solids	5000 -10000 mg/L
04	Total dissolved Solids	6000 -100000 mg/L
05	Chemical Oxygen Demand	85000 - 1115000mg/L
06	Biochemical Oxygen Demand-BOD	

Table -2 Impact of Distillery Waste Water on Natural Water bodies.

Effects on natural Water bodies	Effects on land
[1] lowering the pH value of the stream	[1] pollution of ground water
[2] increase in organic load	[2] charring of vegetation and crops
[3] depletion of dissolved oxygen content	[3] accumulation of salts
[4] discoloration of water	[4] increase in cropping periods
[5] destruction of aquatic life	[5]increase of conductivity of soil
[6] odour, pathogenic smell	[6] change in soil texture
[7] changes in mineral contents of the water	[7] changes in mineral c ontents of the soil

Distillery waste water is generally treated with physico-chemical treatments like coagulation, adsorption, reverse osmosis, etc., but these treatments have met with little success due to high cost and enormous amount of sludge produced, which require further treatment. Of the several biological treatment methods available, anaerobic digestion followed by aerobic treatment has gained wide acceptability due to methane recovery in anaerobic step of the treatment [2],[3],[4]. However, the effluent, even after aerobic treatment, contains appreciable levels of COD and is highly colored which poses serious problem of disposal [5].

In the present work, biocomposting of distillery waste for zero discharge has been studied. The work includes the study of abiotic factors, affecting decomposition rate and biocomposting of distillery waste. Biocomposting is a biological decomposition and stabilization of organic substrats under conditions that allow development of thermophillic microbes as a result of heat produced during fermentation. The resultant product, i.e., the bio-compost is stable, free of pathogens, and can be directly applied on the land as manure. Microbial inoculum was also provided for faster and complete fermentation. . Biocompost has an edge over chemical fertilizers with regard to cost, sustainable fertility as well as higher productivity [Table-3].

TABLE 3
COMPARISON BETWEEN CHEMICAL FERTILIZERS AND BIOCOMPOST

Chemical Fertilizers	Biocompost
1. Normal germination	1. Better germi9nation
2. Normal moisture moisture retention of Agrisoil	2. Much improved water hold-ing capacity
3. NPK [macronutrients]- lack calcium	3. Calcium, sulphur and trace elements [micronutrients] present
4. Normal root development	4. Root development much improved
5. Chemical nitrogen checks mycorrihzal development	5. Microbial life multiplied, enhanced their nutrient transfer
6. Does not act as Nematode barrier	6. Acts as a natural nematode barrier due to micorrhizal fungi
7. No natural vitalization of microbial or animal life	7. Earthworm growth is enhanced resulting into better aeration and natural fertility distribution
8. Destroys the soil structure and texture	8. Improves soil structure and texture
9. Insufficient utilization of nutrients due to leaching	9. Efficient utilization of nutrients due to checked leaching
10. Uptake is influenced by Carbon : Nitrogen ratio	10. Apart from providing NPK, it keeps C : N ratio highly suita-ble due to humus content
11. Excessive use without care of irrigation leads to salinity/ alkalinity	11. Prevents salinity and alkalinity

II. METHODOLOGY

Pressmud, a by-product from sugar mill, was used as a base [main] material for composting. Spent wash and pressmud in the ratio of 1:4 is used for composting on reinforced concrete cement Windrows Platform. Bagasse was also used for biocomposting[7]. Windrows of pressmud were prepared on cement flooring to avoid seepage. Microbial inoculum mixed with partially treated wastewater was then sprayed over pressmud. The windrows were thoroughly aerated by aerotillers to enhance aeration for a period of 40 to 60 days. Controlled moisture content, pH, nutrients and oxygen was maintained to help in proper decomposition and the pressmud.The windrows were finally i converted into a nutrient biomanure, which becomes a good manure for ferti-crop production

III. EXPERIMENTAL WORK

Pressmud and other filtered materials were air-dried to 40 to 60% moisture and then filled in R.C.C/ P.C.C. leakproof, trapezoidal-shaped windrows of about 3.5 meters width, 1.5 meters depth and 100 to 200 meters length. Treated sludge, boiler ash, yeast sludge and bagasse silos were mixed with pressmud to improve their water retaining capacity and to increase volume of filter materials. After putting one layer of pressmud, ash and screened bagasse, the windrows were allowed to dry to a predetermined moisture level, which is usually reached in 3-5 days' time. After that the windrows, inoculated with microbial culture, P Fat 8, at the rate of 400 grams per ton [initially @250 gm./ton for first two weeks and then @15 0gm./ton in last two to three weeks].

Composting Cycle can be divided into two stages:

Stage 1: 8 weeks' cycle windrows dressing.

Stage 2: 2 weeks' cycle for windrows curing.

Stage 1: - The windrows were homogenized and aerated with Enviro 700 aerotiller. After inoculation, temperature increased up to 70 ^{0} C within 48 hours. The windrows were regularly turned, and primary treated effluent was simultaneously sprayed on daily basis. Biological activity of Windrows was monitored during the entire period of 8 weeks. During the process of trilling, moisture was maintained between 50-56% by auto-spraying of distillery pre-treated effluent. Simultaneous turning and spraying were carried out regularly during biocomposting process. Comparative study and observations revealed that bifurcate [stepwise] culture dosing was more effective than one-time dosing of culture.

Stage 2: - After Stage 1 operation, the micro organisms were used up. Most of the decomposable wastewater was biodegraded and, thereby, biocomposting process became slow. Temperature dropped and the compost took on a dark granular texture [Table-4].

TABLE 4
ROUTINE ANALYSIS DURING BIOCOMPOSTING PERIOD

Parameters	*1stweek*	*2^{n}week*	*6th week*	*8th week*
Temperature ^{0} [C]	40	70	60	30
pH	50	7.2	8.0	7.5-7.8
Moisture [%]	70	55	35	25-30

NOTE: TEMPERATURE WAS RECORDED BY DIAL THERMOMETER AND POCKET THERMOMETER. PH WAS DETERMINED BY CYSTRONICS DIGITAL PH METER AND PH STRIPES. MOISTURE WAS ANALYZED BY VACUUM OVEN SYSTEM.

At this stage, the compost was heaped for curing for two weeks. Windrows curing, or curing in heaps, improves the quality of compost. Finally, a distinctive black, loamy compost with pleasant, earthy smell and moisture content of 25-35% was produced [Table-3].The product was named as "*JAGRITI BIOCOMPOST"* The biocompost produced was analysed for its contents. It was also compared to chemical fertilizers and its effects on some crop plants were examined.

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Photograph-1: Windrows of Pressmud and other filtered materials

Photograph 2: Windrows after the addition of ash and screened bagasse.

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Photograph 3: Windrows being aerated by Aerotillers.

Photograph 4: Smoke emanating from windrows due to temperature increase [effect of microbial activities]

Photograph 5: Black, loamy Biocompost – the final product

Photograph 6: Effect of Biocompost on plant

IV RESULTS

The analysis of Biocompost which has been named as "Jagriti Biocompost" provided the results illustrated in Table 5

TABLE 5

AVERAGE ANALYSIS OF PRODUCED BIOCOMPOST [JAGRITI]

Parameters	Values
Carbon:Nitrogen [C:N] ratio	40:1 [Maximum]
Organic Matter [%]	30 [Minimum]
Primary Macronutrients [%]:	
- Nitrogen	1.2 [Minimum]
- Phosphorus	1.5 [Minimum]
- Potassium	3.0 [Minimum]
Secondary Micronutrients:	
- Sulphur	0.6 [Minimum]
- Magnesium	0.3 [Minimum]
- Calcium	4.0 [Minimum]
- Sodium	0.5 [Minimum]
Trace Element and Catalyst:	
- Iron	2000 mg./L
- Manganese	15 mg./L
- Zinc	40 mg./L
- Copper	100 mg/L
- Boron	30 mg./L
- Molybdenum	3 mg./L
Total Microorganism count	74.97x10? CFU
Nitrogen fixing Bacteria	43,000/gram
Humic Index [%]	
-DryCot. Basis	4 [Minimum]
pH of 1% Solution	7.2 to 7.8
BOD of 1% Solution at 27[C]	less than 30 mg./L
COD of 1% Solution	less than 250 mg./L
Cation Exchange Capacity	excess of 70 ME/100 gm.

Effect of Biocompost [Jagriti] and inorganic fertilizers on sugar cane crop was tested in field trials in the month of September, 2002 in the village of Rajaka Sahaspur. The comparison was made in the yield between production without Jagriti Biocompost versus with Jagriti Biocompost . The results were very encouraging. The best results were obtained when the quantity of Jagriti Biocompost was 500 kg. + per acre[Table 6]

TABLE 6

EFFECT OF BIOCOMPOST [JAGRITI] & INORGANIC FERTILIZERS ON SUGAR CANE CROP

SITE: - NATIONAL INDUSTRIAL CORPORATION LTD.
BIO-VILLAGE: RAJAKA SAHASPUR
FARMER: NANDU SINGH FARMHOUSE: 3 ACRES
SEASON: FEBRUARY 2002
DATE OF HARVESTING: SEPTEMBER 2002

Treatment	Grain Yield Without Jagriti Biocompost MT/HAC	Plant Height	Nos.of Tillers	Grain yield with Jagriti Biocompost MT/HAC
T1 Jagriti Biocompost 200 kg/acre	86 MT/HAC	190.00	10.0	90 MT/HAC
T2 Jagriti Biocmpost 300 kg/acre	86 MT/HAC	192.00	11.00	95 MT/HAC
T3 Jagriti Biocompost 400 kg/acre	87 MT/HAC	193.00	12.00	96 MT/HAC
T4 Jagriti Biocompost 500kg/acre	87 MT/HAC	198.00	12.00	102 MT/HAC
T5 Jagriti Biocompost 500+ kg/Acre recommended dose	**87 MT/HAC**	**215.00**	**12.00**	**108 MT/HAC**

FIG. SHOWS AVERAGE PRODUCTION MAY INCREASE WITH BIOCOMPOST JAGRITI APPLICATION.

The effects of Jagriti Biocompost alone, and in combination with Vermicompost and inorganic fertilizers was also studied. There was quantum increase in overall yield, as compared to the control[Table 7].

TABLE 7

EFFECT OF BIOCOMPOST [JAGRITI], VERMICOMPOST & INORGANIC FERTILIZERS ON MAIZE FODDER AND SUGAR CANE YIELD CONTRIBUTING CHARACTER

Treatment	Green Fodder Yield [gm./POT]	Sugar Cane Yield [gm./POT]	Plant Height Fodder/ Sugar Cane	Stem Girth [cm]	Average Breadth of Leaf
Control	73.70	73.76	88.70/ 89.10	4.45	5.0
Only Biocompost	130.65	148.00	115/ 116.90	6.33	6.40
Recommended Dose 120-60 -60 kg/HAC	**130.34**	**148.00**	**114/ 116.00**	**5.25**	**5.22**
75%+RD +1.25T Jagriti/HAC	132.34	159.50	115/ 120	5.43	5.82
75%+RD +1.25T Farmyard Manure	127.34	149.50	115/ 120	5.43	5.82
75%+RD +1.25T Vermicompost/ HAC	112.0	130.00	115/ 118	5.40	5.27

NOTE: -THE ABOVE FIG. SHOWS THE PERCENT INCREASE OVER THE CONTROL.

V. CONCLUSION

A general survey reveals that in a developing country like India, production of chemical fertilizers is still insufficient to meet the demand. This leads to intake of chemical fertilizers on a large scale. Biocompost has a beneficial role to play. It is a viable process of controlling the distillery effluent load without any huge investment, and thus, can reduce the pollution load to the stream. Besides, it is a better substitute to chemical fertilizers as it promotes healthy agricultural products. The agro products with use of biocompost, are usually disease-free.

It is, therefore, concluded that biocomposting of organic matter, including distillery waste should be given its due importance. A movement by the government and non-governmental agencies through awareness training programme, workshops, etc. should be organized for farmers, so that the existing biocomposting efforts may get a quantum leap and it may prove to be a viable alternative to chemical fertilizers.

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