A Study on Effect of Yeast Factory Industrial Wastewater on Physico - Chemical Properties of Soil near Sandila, India

Dr. Mishu Singh

Department of Chemistry, Pt. Deen Dayal Upadhyay Govt. Girls P.G. College, Lucknow, India

***Abstract*: The uncontrolled disposal of yeast factory wastes is not properly designed in most areas. The most common practice followed is evaporation pools or direct discharge for drying on soil which causes severe harm and damages the soil properties affecting its quality and, subsequently deteriorating the quality of groundwater and surface water of the adjoining areas. India being an agriculture-based country has a great demand for water for irrigation purposes. The use of wastewater for irrigation purposes is quite a common practice in India resulting accumulation of toxic substances on the soil. So far there is a lack of reliable information regarding the long-term effects of YFW application on agricultural land. This study assesses the effects of YFW disposal on underlying soil properties in the wider disposal.**

***Keywords*: Yeast Factory, Soil properties, pH, Industrial wastewater, soil contamination, sandy soil.**

I. INTRODUCTION

India is an agronomical country with excessive demand for water for irrigation. Simultaneously the need for water for different industrial processes is also increasing and as a result, a large quantity of effluent is also being discharged into water bodies untreated [1]. The use of industrial effluent released from yeast factories, sugar mills, oil mills, etc. for irrigation purposes has become a common practice in India. The disposal of waste containing toxic substances has affected the agricultural soil quality gravely. Apart from this the untreated effluent has degraded the fertility of the soil and affected the food chain also adversely [2, 3]. Factories producing yeast play a chief role in contaminating the water forms and land by discharging an enormous amount of effluent. Numerous chemicals are used during the manufacturing process mainly for coagulation, removal, and refining of impurities

and the end product. A large amount of effluent is released during the production containing an appreciable amount of pollution load particularly organic matters and organic mud [4, 5]. Discharge of effluent to the land of irrigational land impacts the physicochemical properties of soil unfavorably [6, 7]. Chopra and Pathak,2013 [8] have shown that the release of effluent on irrigational land can be a source of contamination to the soil as some toxic substances may also be transferred to plants from roots to leaves. Baskaran et al have also identified the polluted soil by the industry becomes unsuitable for further cultivation of crops [9].

II. LITERATURE REVIEW

The fate of impurities and the contaminants present in YFW disposed of in lagoons and small ponds can be defined by several physicochemical processes which may lessen, concentrate, restrain, release, degrade or otherwise alter them. Therefore the exact calculation of peril caused by these contaminants depends on the concentration, exposure, and properties of soils [10].

Moreover, if YFW is appropriately mixed and assimilated at adequate loading rates herbicidal action is improved [11], organic matter and the availability of nutrients needed for the growth of plants is increased and hence, the fertility of the soil and its productivity is also increased [12]. On the other hand, the use of wastewater for agricultural purposes may cause alkalinity, acidity, immobilization of nitrogen, etc (Brunetti et al. 2007). The conventional methods used for the treatment of wastewater include disposal in shallow evaporation ponds and discharge on land. Sometimes it is utilized for the production of fermentation products and oils preservatives [13]. Although direct disposal of untreated industrial waste is not allowed it is still estimated that almost 1.5 million tonnes of yeast factory waste are disposed of every year in aquatic streams and land [14]. The usual treatment and disposal practices followed in India are disposed of in the sea, river, or open land.

III. MATERIAL AND METHOD

*Study Area***:** The Area under study belongs to the municipality of Sandila, prefecture of Hardoi, Uttar Pradesh, India, coordinates being 27°4′48″N 80°31′12″E. [15]. The region has a humid subtropical climate and is characterized by extreme winters, dry-hot summers, and rainy seasons. The area experiences the lowest average temperature of 10.3^0C in January and the maximum average temperature is 47^0 C in June. The average rainfall is about 690 mm, most of which falls between October and April while no precipitation is seen during summer [16]. Soil samples under study were found to be silt, clayey, moderately alkaline, and high in carbonate content.

Wastewater Analysis

The main chemical parameters of YFW (Yeast Factory Wastewater), namely pH, Total Organic Carbon, BOD, COD, TDS, DO, total Kjeldahl N, and P were analyzed by established methodologies [17].

Soil Sampling:

The soil used in this study was collected from the pond wall and selected distances up to 10 meters and a depth ranging from 25 cm to 100 cm in February. Samples were collected and brought to a lab located far away from the disposal site where the possibility of further soil contamination is zero. Samples were brought to the lab, dried in the air, crushed gently to pass through a sieve of 2 mm, and stored at room temperature. The soil contains on average 500 g/ kg silt, 45 g/kg clay, and 220 g/ kg sand.

Soil analysis:

Laboratory determinations were performed according to the methods usually used for soil characterization. Soil Analysis to determine Physico-chemical parameters was done using standard methods [18]. Particle size distribution was carried out using the Bouyoukos method [19]. pH is determined by the Electrometric method instrument used is a pH meter, Total organic matter is analyzed by dichromate oxidation method [20]; total N by the Kjeldahl method, and available phosphorous using sodium hydrogen carbonate extraction method.

IV. RESULTS AND DISCUSSION

Yeast Factory Wastewater Analysis: the effluent released from the factory was found to have the following characteristics given in Table 1.

Table 1- Physico Chemical Parameters of Yeast Factory Wastewater

S. No	Physico Chemical Parameters of Yeast Factory Wastewater	Value
1	pH	7.5-7.9
2	Total Organic Carbon	39-42 gL^{-1}
3	Dissolved Oxygen(DO)	0-3.5 mgL^{-1}
4	BOD	40–47 gL^{-1}
5	COD	60–79 gL^{-1}
6	Total Kjeldahl N	755–795mgL^{-1}
7	Phosphorous	435–485 mgL^{-1}
8.	Hardness, $CaCO_3$	21.2%
9.	Total Dissolved Solids (TDS)	9.4 gL^{-1}

Results in Table -1 showed that YFW is characterized by relatively low pH from 7.5 to 7.9 and DO values up to 3.5 mg/L, respectively. The concentration of total dissolved solids is around 9.4 g/L. BOD and COD values are quite high ranging between 40–47 gL^{-1} and 60–79 gL^{-1} respectively.

Colour:

The colour of the effluent released was witnessed visually and it was found that the effluent released was dark brown in colour. Its brown colour could be due to the presence of melanoidin, which is the condensation product of amine of carbohydrates. The appearance of water before it is discharged into water bodies and land is very important.

Table 2- Properties of soil samples collected from various depths and distances.

Soil Properties	Soil Depth (cm)	Distance form pond wall			
		Site 1 (S1)	Site 2 (S2)	Site 3 (S3)	Site 4 (S4)
		2.5m	5m	7.5	10m
	25	7.5	7.5	7.7	7.9
pH	50	7.5	7.7	7.8	7.9
	100	7.5	7.9	7.8	7.9
Organic	25	5.7	4.9	3.6	3.4
Matter %	50	4.9	3.5	3.5	2.4
	100	3.8	2.4	1.8	1.6
Kjeldahl N	25	0.8	1.9	2.5	2.7
(mg g−1)	50	0.6	1.1	1.6	2.6
	100	0.8	1.6	1.8	2.3
Total P	25	15	44	55	69
(mgkg−1)	50	18	58	67	116
	100	42	63	83	151
	25	17.6	7.2	9.8	7.6
CaCO3 %	50	16	4.2	10.2	8.4
	100	9.7	3.4	8.8	7.1

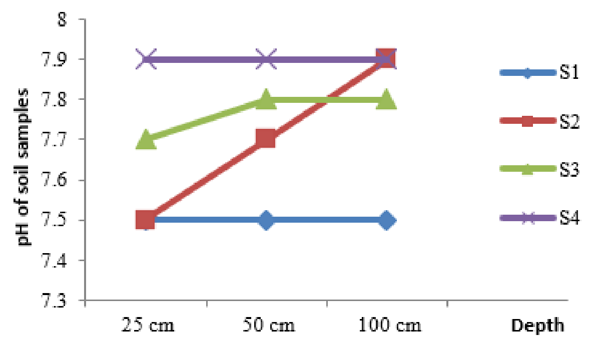

Figure 1: Change in pH of soil at different depths at different Sites

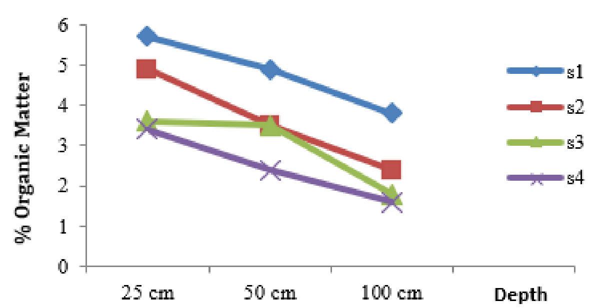

Figure 2: Change in % Organic Matter of soil at different depths at different Sites

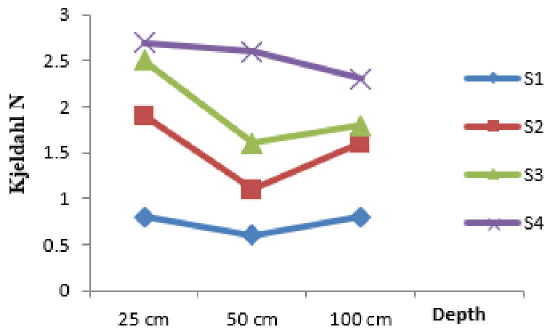

Figure 3: Change in Kjeldahl N of soil at different depths at different Sites

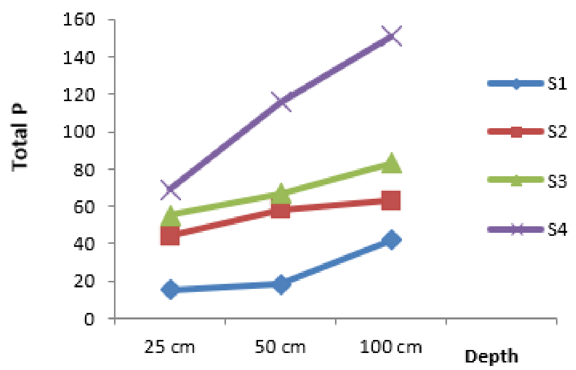

Figure 4: Change in Total P of soil at different depths at different Sites

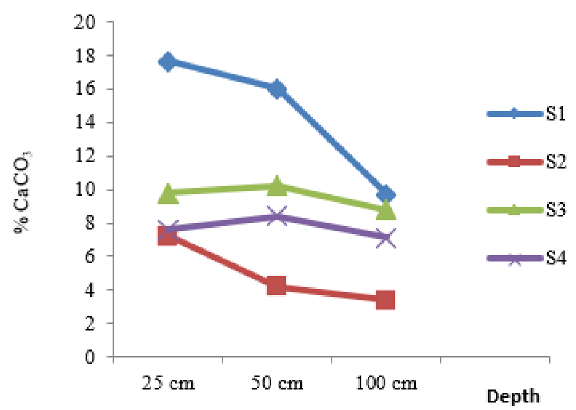

Figure 5: Change in % $CaCO_3$Total P of soil at different depths at different Sites

Soil Acidity (pH) and Carbonate Content:

pH values of the soil samples as mentioned in Table 1 indicate that disposal of YFW considerably affects the acidity of the surrounding soil. There was not much difference in the pH of the effluent and the soil samples near the pond where the effluent was released. The low value of pH indicates that most of the acidity is neutralized by the carbonate content of the soil and that surface application of YFW does not markedly affect soil pH in the long term [21]. Figure -1 represents the change in the value of pH at the depth of 25, 50, and 100 cm respectively at four different sites viz. S1, S2, S3 & S4 at the distance from the pond's wall.

Organic Matter and Total Nitrogen:

The percentage of organic matter was high in the topsoil layer but it gradually reduced with increasing depth. The small increase in the percentage of organic matter in the topsoil is due to the direct contact between the pond and the upper layer. As with the amount of organic matter in the soil, the total nitrogen does not seem to be affected by the N surplus in the top soil of the pond and it is gradually decreased with soil depth. Figure -2 and Figure-3 represent the change in the organic matter and nitrogen at the depth of 25, 50, and 100 cm respectively at four different sites viz. S1, S2, S3 & S4 at the distance from the pond's wall.

Available P

Soil near the pond was very rich in available P. Surface disposal of YFW increased the concentration of extractable P in topsoil up to 3 times. The overloading of soils with phosphorous increases the risk of surface water contamination. The environmental concern of allowing P to accumulate to very high levels in the soil is the long period required to reduce P to levels normally recommended for agronomic production. High levels of P can be reduced only after 15–20 years of continuous crop harvesting, provided that no additional P from any source is added during this period [22, 23]. Figure - 4 represents the change in the value of total phosphorous at the depth of 25, 50, and 100 cm respectively at four different sites viz. S1, S2, S3 & S4 at the distance from the pond's wall.

Carbonate Content:

The carbonate content of the upper soil layer in the pond at surface disposal points was considerably lower in all soil samplings. Carbonates, present in the soil, buffer the acidity of the waste by generating soluble calcium bicarbonate, which infiltrates to the lower horizons and precipitates again as calcium carbonate. Figure -5 represents the change in % $CaCO_3$ at the depth of 25, 50, and 100 cm respectively at four different sites viz. S1, S2, S3 & S4 at the distance from the pond's wall.

V. CONCLUSION

Disposal of untreated YFW in evaporation ponds has significant effects on the chemical properties of the underlying soil. In particular, soil samples are characterized by an increase in alkalinity, low carbonate percentage, increased organic load, and high content of total nitrogen and total phosphorous. The results of the study show that yeast factory effluent which is discharged to nearby land can't be used by the farmers for irrigation purposes and has affected the soil properties adversely. The effluent contains a high amount of organic waste which increases the organic matter in the soil if this water is used for irrigation further. Disposal of acidic YEW on oils enables neutralization of the waste pH but soil pH is only temporarily affected.

Further studies are essential to assess the long-term effect of uncontrolled YFW disposal in evaporation ponds and agricultural land and assess the risk for soil and water contamination. Specific attention should be also paid to the fate of recalcitrant contaminants present in soils.

Abbreviation: YFW- Yeast Factory Wastewater

REFERENCES

[1] Saranraj, P. & Stella, D. (2014). Impact of Sugar mill effluent to environment and bioremediation: A Review. World Applied Sc. J., 30(3): 299- 306.

[2] Mahavi, R. (2005). Biotechnology application to environmental remediation in resource exploitation. Current Sci., 97: 6-25.

[3] Sinha, S., Singh, S. & Mallick, S. (2008). Comparative growth response of two varieties of Vigna radiata L. (var. PDM 54 and var. NM 1) grown on different tannery sludge applications: effects of treated wastewater and ground water used for irrigation. Environ. Geochem. & Health, 30: 407–422.

[4] Muthusamy, P., Murugan, S. & Manothi, S. (2012). Removal of Nickel ion from industrial wastewater using maize cob. J. of Biol. Sci., 1(2): 7-11.

[5] Thambavani, S. D. & Sabitha. M. A. (2012). Multivariate statistical analysis between COD and BOD of sugar mill effluent. Scholarly J. of Maths and Computer Sci., 1(1): 6-12.

[6] Nagaraju, G. N. & Rangaswami, V. (2007). Impact of effluents of sugar cane industry on soil physico-chemical and biological properties. J. Ind. Pollut. Cont., 23: 73-76.

[7] Narasimha, G., Babu, G.V.A.K. & Reddy, R. B., (1999). Physicochemical and biological properties of soil samples collected from soil contaminated with effluents of cotton ginning industry. J. of Environ. Biol., 20: 235–239.

[8] Chopra, A. K. & Pathak, C. (2013). Enrichment and translocation of heavy metals in soil and Spinaceaoleracea grown in sugar mill Effluent irrigated soil. Sugar Tech., 15(1): 77–83.-9

[9] Baskaran, L., Sankar, K., Ganesh, Chidambaram A.L.A. & Sundaramoorthy, P. (2009): Amelioration of sugar mill effluent polluted soil and its effect of green gram (Vigna radiata L.) - Botany Research International., 2 (2): 131-135

[10] Zaharaki D, Komnitsas K (2009) Existing and emerging technologies for the treatment of olive oil mill wastewaters, 3rd Amireg International Conference Proceedings (in Cd-ROM): Assessing the Footprint of Resource Utilization and Hazardous Waste Management (eds. Z. Agioutantis, K. Komnitsas), 7-9 Sep. 2009, Athens, Greece.

[11] Kotsou M, Mari I, Lasaridi K, Chatzipavlidis I, Balis C, Kyriacou A (2004) The effect of olive mill wastewater (OMW) on soil microbial communities and suppressiveness against Rhizoctonia solani. Appl Soil Ecol 26:113-121

[12] Mechri B, Mariem FB, Baham M, Elhadj SB, Hammami M. (2008) Change in soil properties and the soil microbial community following land spreading of olive mill wastewater affects olive trees key physiological parameters and the abundance of arbuscular mycorrhizal fungi. Soil Biol Biochem 40:152-161

[13] A. Roig, M.L. Cayuela, M.A. Sànchez-Monedero,Anoverview on olive mill wastes and their valorisation methods, Waste Manage. 26 (2006) 960–969.

[14] J.E. Kapellakis, K.P. Tsagarakis, C. Avramaki, A.N. Angelakis, Olive mill wastewater management in river basins: a case study in Greece, Agric. Water Manage. 82 (2006) 354–370.

[15] https://en.wikipedia.org/wiki/Sandila

[16] https://www.myweather2.com/City-Town/India/Sandila.aspx

[17] L.S. Clesceri, A.E. Greenberg, A.D. Eaton, Standard Methods for the Examination of Water and Wastewater, 20th ed., APHA, AWWA, WEF, Washington, DC, 1998.

[18] A.L. Page, R.H. Miller, D.R. Keeney (Eds.), Methods of Soil Analysis, Part 2: Chemical and Microbiological Properties, American Society of Agronomy, Madison, Wisconsin, 1982.

[19] G.J. Bouyoucos, Hydrometer method improved for making particle and size analysis of soils, Agron. J. 54 (1962) 464–465.

[20] Standard operating procedure for soil calcium carbonate equivalent. Volumetric Calcimeter method. Rome, FAO. 2020.

[21] Pal, Dilip. (2015). Re: What is the best method to determine the NH4-N in soils? Retrieved from: https://www.researchgate.net/post/What_is_the_best_method_to_determine_the_NH4-N_in_soils/54ffe269f15bc7b2528b45ed/citation/download.

[22] 8.SierraNJ,NMartíNE,NMontserratNG,NCruañasNR,NGarauNMAN(2001)NCharacterization and evolution of a soil affected by olive oil mill wastewater disposal. Sci Total Environ 279:207-214

[23] D.H. Pote, T.C. Daniel, A.N. Sharpley, P.A. Moore, D.R. Edwards Jr., D.J. Nichols, Relating extractable soil phosphorus to phosphorus losses in runoff, Soil Sci. Soc. Am. J. 60 (1996) 855–859.

.