Nature Environment and Pollution Technology *An International Quarterly Scientific Journal*	Vol. 7	No. 4	pp. 737-741	2008

Original Research Paper

Assessment of Physicochemical Characteristics of Liquid Effluent from Agro Oil Industry and its Applications

P. V. S. Machiraju, V. Srinivasa Rao* and Y. L. N. Murthy**

Department of Chemistry, P. R. Govt. College (Autonomous), Kakinada-533 001, A.P., India

*Department of Chemistry, Aditya P.G. College, Kakinada-533 003, A.P., India

**Department of Chemistry, Andhra University, Visakhapatnam-530 003, A.P., India

Key Words:
Agro oil industry effluent
RSC
Wastewater irrigation
Aquaculture

ABSTRACT

The liquid effluent treated from agro oil industry has an alkaline pH and lower level of dissolved oxygen (DO), which affects the aerobic respiration of organisms, and hence, not suitable for aquaculture application. Higher values of residual sodium carbonate (RSC), electrical conductivity, sulphate and total dissolved solids also suggest that the liquid effluent after treatment is also not suitable for irrigation purposes.

INTRODUCTION

Among the large and medium scale industries in India, more than 45% are depending on the agricultural sector as a source of their raw materials. Almost one-half of our industries are agro-based. Industries, which manufacture edible oils and vanaspati, also categorized under agro-based. Most of the major agro-based industries are located in the States of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and Uttar Pradesh. As a whole there are 725 edible oils and vanaspati industrial units which have 4.5×10^6 tons/year as annual production capacity. The agro-based industry generates large volumes of liquid effluents. The agro-based industry is the second largest generator of pollution having organic matter in the country standing next only to the domestic sewage. The agro oil industry under this study has a production capacity of 400 metric tons of vanaspati and 800 metric tons of vegetable refined oil. The raw materials employed in this industry include palm oil, soft oil, sesame oil, bleaching earth, citric acid, nickel catalyst, hydrogen gas, vitamins A and D, and phosphoric acid for the production of vanaspati. The raw materials employed for the production of vegetable refined oil include vegetable oil, phosphoric acid, bleaching earth and citric acid. Ground water is being used as source of water and the quantity of water being used is 400 kilolitre/day.

The influence of olive oil mill wastewater on soil characteristics and morphology studied by Sierra et al. (2001) indicates that the wastewater infiltration in the soil caused carbonate dissolution, and redistribution and modification in soil pH, electrical conductivity, nutrient content, phenolic compounds and biological activity of soil horizons. The suitability of olive oil wastewater for composting application was assessed and the appearance of phytotoxicity was observed (Paredes et al. 2001). Studies by El Hardrami et al. (2003) revealed the suitability of olive oil wastewater for agricultural purposes. Significant increase of root peroxidase activity was observed in case of Chickpea (3 times) and maize (5 times), and a significant decrease (5 times) in wheat were observed. Investigations were carried out (Riffaldi et al. 1992) on the effect of wastewater from olive in extraction properties of mill olive grove oil. The studies revealed that the wastewater from olive oil processing with pH 4.3 was applied to a sandy soil in an olive plantation. The treatment increased the Cl^- and EC, and decreased NO_3^- content of the soil.

Keeping in view of the agricultural and industrial prospects of East Godavari region, Andhra Pradesh and the importance of demand and production of edible oils, this study has been carried out on characterization, potential and prospects of utilizing the liquid effluent generated at ETP from an agro oil industry.

MATERIALS AND METHODS

The samples of the process and effluent waters before and after treatment were collected and preserved for analysis as per standard procedures (Ramteke & Moghe 1998). The measured parameters include pH, electrical conductivity, total solids, anionic species like chloride, sulphate, phosphate and fluoride, carbonate and bicarbonate, total hardness and calcium and magnesium hardness, concentration of metallic calcium and magnesium, residual sodium carbonate (RSC), and dissolved oxygen (DO), biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Standard analytical procedures (Ramteke & Moghe 1998) were followed for determination of these parameters. The value of residual sodium carbonate (RSC) was calculated by the following formula.

$$RSC = (CO_3^{2-} + HCO_3^-) - (Ca^{2+} + Mg^{2+}) \text{ (Values in meq/L)}$$

RESULTS AND DISCUSSION

Characterization of intake water: It is significant to characterize the intake water which is employed in different processes by the industry. Quality of water employed by the present industry is

Table 1: Characterization of intake water employed in the agro oil industry.

S. No.	Parameter	Units	Observed value
1	pH	-	8.1
2	Electrical Conductivity	μmhos	864
3	Total Solids	mg/L	560
4	Total Dissolved Solids (TDS)	mg/L	480
5	Total Suspended Solids (TSS)	mg/L	80
6	Carbonate as (CO_3^{-2})	mg/L	9.6
7	Bicarbonate (HCO_3^-)	mg/L	185
8	Residual Sodium Carbonate (RSC)	me/L	BDL*
9	Hardness	mg/L	248
10	Calcium Hardness	mg/L	180
11	Magnesium Hardness	mg/L	68
12	Ca^{2+} ion concentration	mg/L	72
13	Mg^{2+} ion concentration	mg/L	16.5
14	F^- ion concentration	mg/L	0.373
15	Cl^- ion concentration	mg/L	104
16	SO_4^{-2} ion concentration	mg/L	9.6
17	PO_4^{-3} ion concentration	mg/L	0.226
18	Dissolved Oxygen (DO) (Max.)	mg/L	4.0
19	Biochemical Oxygen Demand (BOD) (Max.)	mg/L	BDL*
20	Chemical Oxygen Demand (COD) (Max.)	mg/L	10

*BDL - Below Detectable Limit

Table 2: Water classification for irrigation purposes.

Class of Water	TDS (mg/L)	Chlorides (mg/L)	Sulphates (mg/L)	Electrical conductivity (µmhos/cm)	Suitability for irrigation
I	0-700	0-142	0-192	0-750	Excellent to good for irrigation
II	700-2000	142-355	192-480	750-2250	Good to injurious. Suitable only with permeable soil and moderate leaching. Harmful to sensitive crops.
III	> 2000	> 355	> 480	> 2250	Unfit for irrigation

given in Table 1. The observed data show with reference of standards that the intake water can be classified as class I category (CPCB 1995) .

On the basis of presence of different constituents in water, water is classified into three grades for irrigation purposes (Goel 2001) as given in Table 2.

Residual sodium carbonate (RSC): Residual sodium carbonate (RSC) is an important parameter to assess the suitability of water for irrigation (Gupta 2004) (Table 3).

RCC value < 1.25 **-** Water can be safely used for irrigation
RSC Value 1.25**-**2.50 **-** Water to be used with due caution
RSC Value > 2.50 **-** Water unsuitable for irrigation

The observed RSC value (30.78 meq/L) of the treated liquid effluent is above the permissible limit, and hence, it is not suitable for irrigation purpose.

Characterization of liquid effluent: As the agro oil industry produces considerable quantity of liquid effluent, which creates pollution, it is necessary to characterize the effluent generated from the ETP of the industry before and after treatment, and the analytical data are presented in Table 4.

In this investigation the value of pH of the effluent after treatment is in the alkaline range. The electrical conductivity value of the effluent after treatment (7400 µmhos/cm) is considerably high which indicates its excessive saline nature and hence the effluent is not suitable either for irrigation or for aquaculture purposes (USSL 1953). The total dissolved solids value of 15611 mg/L of the treated effluent is very high indicating high salinity which can not be used for irrigation purposes. The values of fluoride (1.03 mg/L), chloride (79 mg/L) and phosphate (2.067 mg/L) are within the permissible limits. The value of sulphate ion concentration (1367 mg/L) is high above the permissible limits making water unsuitable for irrigation. Dissolved oxygen (1.6 mg/L) is low which may affect the aerobic respiration of organisms and hence it is unfit for aquaculture.

The biochemical oxygen demand (BOD) value (84 mg/L) of the liquid effluent after treatment is within the limits of irrigation standards (100 mg/L), but high (84 mg/L) compared to aquaculture standards (30 mg/L). The chemical oxygen demand (209 mg/L) is with in the limits of aquaculture standard (250 mg/L).

CONCLUSIONS

1. Though the values of parameters such as fluoride, chloride and phosphate are within the permissible limits, the values of electrical conductivity and total dissolved solids indicate that the effluent after treatment is unfit for irrigation purposes.

Table 3: Calculation of RSC content of liquid effluent before and after treatment.

	Parameter	Units	Observed Value	
			Before Treatment	After Treatment
1	CO_3 content	mg / L	BDL*	264
2	HCO_3 content	mg / L	8662	2098
3	Ca^{2+} ion concentration	mg / L	88	72
4	Mg^{2+} ion concentration	mg / L	234	53.68
5	Residual Sodium Carbonate (RSC)	me / L	118.33	30.78

*BDL: Below Detectable Limit

Table 4: Characterization of untreated and treated liquid effluent from the agro oil industry.

Sl. No.	Parameter	Standards		Observed Value	
		Irrigation	Aquaculture	Before treatment	After treatment
1	pH	5.5-9.0	5.5-9.0	7.7	8.3
2	Electrical Conductivity (μmhos/cm)	Class-I: 0-750 Class-II: 750-2250 Class-III: > 2250	-	24600	7400
3	Total Solids (mg/L)			25429	16131
4	Total Dissolved Solids (TDS) mg/L	Class-I: 0-700 Class-II: 700-2000 Class-III: > 2000	2100	16720	15611
5	Total Suspended Solids (TSS) mg/L (Max.)	200	100	8709	520
6	Hardness (mg/L)			1180	400
7	Calcium Hardness (mg/L)			220	180
8	Magnesium Hardness (mg/L)			960	220
9	F^- ion (mg/L) (Max.)	-	2.0	6.787	1.03
10	Cl^- ion concentration (mg/L)	Class-I: 0-142 Class-II: 142-355 Class-III: >355	-	249	79
11	SO_4^{2-} ion concentration (mg/L)	Class-I: 0-192 Class-II: 192-480 Class-III: > 480	-	1476	1367
12	PO_4^{3-} ion (mg/L) (Max.)	-	5.0	409	2.067
13	Dissolved Oxygen (DO) (mg/L)	-	50	BDL	1.6
14	Biochemical Oxygen Demand (BOD) (mg/L) (Max.)	100	30	12000	84
15	Chemical Oxygen Demand (COD) (mg/L) (Max.)	-	250	33600	209

2. Though the value of COD (84 mg/L) of the treated effluent from the industry is within the permissible limits, the values of dissolved oxygen and BOD indicate that the effluent is not suitable for irrigation and aquaculture purposes.

Hence, the liquid effluent generated from the agro oil industry, in general, is not suitable either for aquaculture or for irrigation purposes.

ACKNOWLEDGEMENT

The authors are thankful to A.P. Pollution Control Board, Regional Office, Kakinada, A.P, India for the help and co-operation extended.

REFERENCES

Sierra, J., Marti, E., Montserrat, G., Cruamas, R. and Gaurav, M.A. 2001. Characterization and evolution of a soil affected by olive oil mill wastewater disposal. Science of the Total Environment, 279(1-3): 207-214.

Paredes, C., Bernal, M.P., Roig, A. and Cegarra 2001. Effects of olive oil mill wastewater addition in composting of agroindustrial and urban wastes. J. Biodegradation, 12(4): 225-234.

El Hardrami, Abdel basset., El Idrissi-Monbtassim, Hafid., EI Hassni, Majida, Abbad, Abdelaziz and El Hardrami, Ismail. 2003. The fertirrigation by olive mill wastewaters induces biosynthesis and accumulation of phenolics in three Mediterranean crops. Polyphenols Actralities, 23: 27-30.

Reffaldi, Riccardo, Saviozzi, Alsesseandro and Levi-Minzi Renato 1992. Effect of wastewater from olive oil extraction on properties of hill olive grove soil, Bertolacci, Mercello. Ingrinamento, 34(1): 38-43.

CPCB 1995. Pollution Control Acts, Rules and Notifications Issued Thereunder. Central Pollution Control Board, New Delhi, India.

Ramteke, D.S. and Moghe, C.A. 1998. Manual on Water and Wastewater Analysis. National Environmental Engineering Research Institute, Nagpur, India.

Goel, P.K. 2001. Water Pollution, Causes, Effects and Control. New Age International (P) Limited, Publishers, New Delhi, India.

Gupta, P.K. 2004. Methods in Environmental Analysis, Water, Soil and Air. Agrobios (India).

USSL 1953. Diagnosis and Improvement of Saline and Alkali Soils, US Salinity Laboratory, US Deptt. Agri. Handbook No. 60, Washington DC.