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Anaerobic-aerobic Activated Sludge Treatment followed by Phytoremediation to Dairy Effluent

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ABSTRACT

India is a developing country and hence more attention paid to improve the quality and quantity of milk and milk products than that of the effluent treatment. Direct or indirect disposal of dairy effluents into the natural water bodies generates Eutrophication, serious health effects on aquatic animals and human health also. The present study is carried out to find an efficient treatment using anaerobic aerobic activated sludge treatment followed by phytoremediation for the Dairy effluent. The microbes of endogenous origin are used to treat the Dairy effluent and Phytoremediation by the aquatic macrophyte *Eichhornia crassipesis* done. The results of current study illustrated that BOD, COD, TS, Sulphate, Chloride and BOD**:** COD ratio are 86%, 87%, 96%, 75%, 89% and 0.99 **:** 1 respectively which very higher percentage of reduction and covers the safe disposal standers for Dairy effluent.

Keywords: Bioremediation, Dairy wastewater; Phytoremediation; Activated sludge treatment.

1. INTRODUCTION:

Dr.Verghese Kurien, known as the Father of the White Revolution in India due to the "billion-litre idea", developed the world's largest agricultural dairy development program, and now India is world's largest milk producer with about 17 percent of global output in 2010–11 (Kurien Verghese, 2007). With the exponential increase in the number of industries, there has been a substantial increase in generation of industrial wastewater, which is discharged either into open land or nearby aquatic

ecosystems (Banupriya and Gowrie, 2012). Direct disposal of dairy effluent discharged in to streams without treatment results in rapid depletion of dissolved oxygen (DO) and encourage growth of sewage fungi to cover the entire bottom of the stream i.e. Eutrophication (Forsber, 1998) and effluent rich in organic matter and thus leading to creation of odorous and high COD containing water (Harush, 2011). The dairy industry on an average has been reported to generate 6-10 liters of waste water per liter of the milk processed (Kolhe and Power, 2011). The quality of effluent also plays an important role in design and construction of various treatment units. Dairy effluent collected and performed physicochemical analysis and endogenous culture isolation for anaerobic-aerobic activated sludge treatment, followed by phytoremediation study using aquatic macrophyte *Eichhornia crassipes.* The efficiency of treatments were checked by performing physicochemical characterization using parameters TS (Total Solids), BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), Chloride and Sulphate.

2. MATERIAL AND METHOD:

Scientific research studies are performed in definite design and following are the steps in detail for the current study.

1. Collection and physicochemical analysis of Dairy Effluent:

The effluent samples were collected from a dairy located 73^0 East and 15^0 North and near about 5 km. away from the National Highway number four, District Pune; Maharashtra (India). The sample was collected in duplicate by composite sampling at the time 9, 12, 3, 6 O'clock in a clean sterile plastic container and stored at 4^oC until the analysis was carried out according to the methods of APHA (1985). The flow rate of effluent average daily is 14 MGD. The samples were analyzed physically for parameters such as pH, DO (dissolved Oxygen), TDS (Total dissolved Solids), TS (Total Solids), TSS (Total Suspended Solids), BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), chloride, Sulphate, oil and Grease (APHA, 1985; Trivedy and Goel, 1984). The pH of samples was determined by pH meter and temperature in Degree Celsius on scientific thermometer. TS, TDS and TSS estimated by gravimetric method, Chloride and DO determined by titration method. Chemical oxygen Demand (COD) analyzed and Biological Oxygen Demand (BOD) analyses for incubation at 20^0C for 5 days.

2. Isolation of bacteria and Anaerobic-aerobic Activated Sludge Treatment to Dairy Effluent:

Isolation of bacteria from dairy effluent which previously analyzed by physicochemical parameters. The Selective dilutions were spread on nutrient agar and incubated for 24 hours at room temperature and randomly colonies are selected then characterized (cultural, morphological and Biochemical) and identified for

activated sludge treatment. Before treatment, the dairy effluent samples were stabilized in stabilization tank (10 liter plastic) to remove oil and grease using grease traps and screens and 700 ml broth culture of isolate with density 10^8 organism/ml is mixed with 7000 ml of Dairy effluent in 10 liter plastic container as reactor. The reactor was connected with two glass bottles, one for the collection of gases and other for collection of displaced water from the gas bottle. Tubes were connected to facilitate addition of raw effluent, for removing of treated effluent and for also gas transfer. Diammonium phosphate (DAP) and urea are used as an additional nitrogen source, anaerobic conditions for one day (24hrs) under by total sealing with Plaster of Paris (POP) and then followed by Aerobic Activated sludge treatment using small mechanical aerator with capacity 2 lb. O_2/ hp-hr and for aerobic conditions and then physicochemical parameters are analyzed. To maintain the flow rate 1ml/min, the hydraulic retention time (HRT) of Activated sludge treatment was 24 hrs., p^H (7.31 ± 0.10)and temperature (26 ± 5ºC) were maintained during the anaerobic digestion while in aerobic digestion sludge volume index (SVI) and mix liquor suspended solid (MLSS) were maintained to an average value of 64 ± 2.6 ml/g (61.1 ± 2.6 ml/g) and 3 ± 2.5 g/L (2.72 g/l) respectively.

3. Collection and Phytoremediation of Aquatic Macrophyte

The aquatic plants were collected from "Sirpiraji Gatage Lake" the Murgud dam of Lat. 16º. 23' and Long 74º 12'. Samples were collected by wading into the river, picking the whole plant in undamaged condition and holding it and stored in labeled plastic bags from the 3 sites, biomass about 32 gm., three-day sampling period for each plant species with comparisons being made between sites and season using a one way-ANOVA at $p < 0.05$. These plants were also allowed to establish for thirty days, harvested into 2 liter plastic tanks containing Sirpiraji Gatage lake water and allowed to free-float and processed for the treatment of dairy effluent. The phytoremediation treatment to the dairy effluents which is previously treated with anaerobic- aerobic activated sludge treatment, by using the aquatic macrophyte *Eichhornia crassipes (water hyacinth)* was done in three replicates in the 2 liter plastic tanks, flow rate 1ml/min for effluent, p^H (7.31 ± 0.10) and temperature (26 ± 5ºC) were maintained during the treatment (Kanabkaew and Puetpaiboon, 2004; NASA, 1986) and the treated effluent Samples were analyzed physically for parameters such as T.S. and chemically for parameters such as D.O. B.O.D., C.O.D., Sulphate, chloride (APHA, 1985; Trivedy and Goel, 1984).

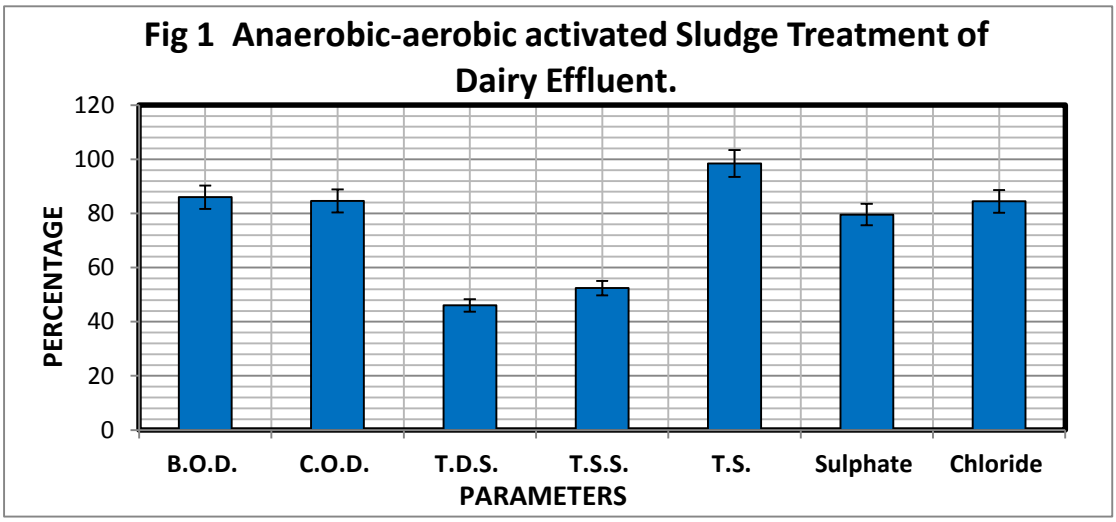
4. RESULTS AND DISCUSSION:

All the research work carried out in each and every day of the year 2015 then monthly average converted into yearly and all the data represented in this paper briefly arranged. The current study site is a dairy from Pune (India) with total Milk and Milk Products processing 48519862 liter/year. Each and every one liter milk processing required 6-10 liters water, and hence total effluent 19,40,79,448 (±48519862) Liter/year which per day water requirement. The Dairy effluent collected by

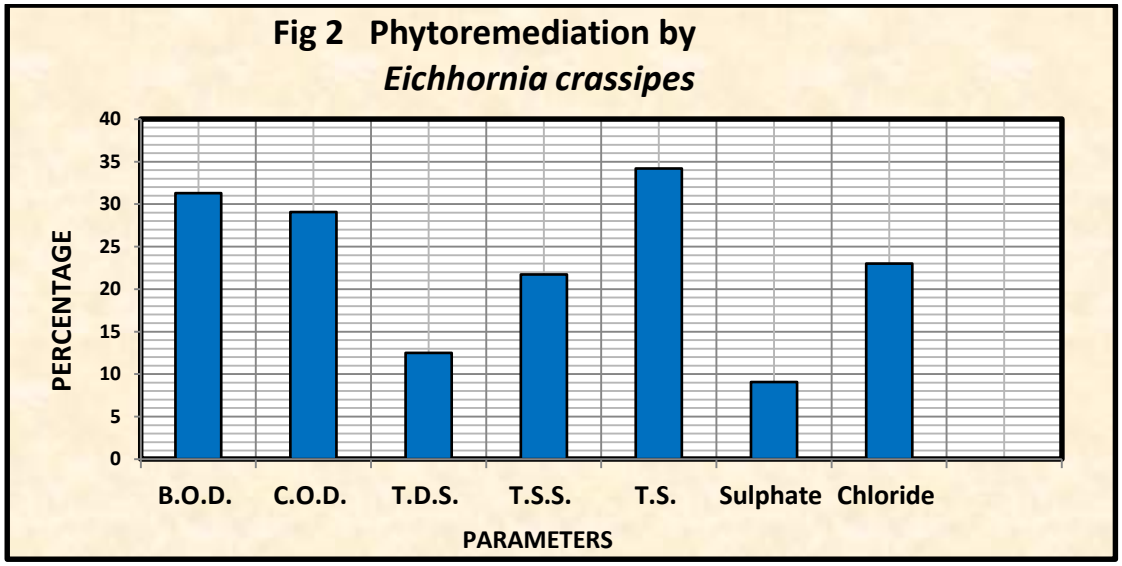
composite sampling in five replicates and mean values of physicochemical parameters analyzed like Temp., pH, Oil & Grease, T.D.S., T.S.S., T.S, D.O., B.O.D., C.O.D., Sulphate, Chloride are 29.52^{0}C, 9.93, 12.61 mg/L, 1653.7 mg/L, 242.88 mg/L, 1999.26 mg/L, 1.32 mg/L, 664.56 mg/L, 1507.6 mg/L, 1224.8 mg/L, and 154.17 mg/L respectively and represented in Table 1. These values are greater than Standard limits for Agriculture Irrigation given by the Maharashtra pollution control board (India). The standard limit for Agriculture Irrigation are as follows: for pH, B.O.D., C.O.D. ,S.S., Oil & Grease, T.D.S., Sulphate, Chloride are 5.5–9, 100 mg/L, 250 mg/L, 200 mg/L, 10 mg/L, 2100 mg/L, 1000 mg/L, 600 mg/L respectively. In fig 1 and fig. 2 represents the mean valve of parameter analysis after treatment indicated the column graph with percent error bar of anaerobic-aerobic activated sludge treatment and phytoremediation by *Eichhornia crassipes.*

Table 1: Physico-chemical Analysis of Dairy Effluent.

Parameter	Effluent Mean in (mg/L)	SD(σ)	SD Error	Anaerobic-aerobic activated Sludge Treatment in (%)	Phytoremediation by *Eichhornia crassipes* Mean *in* (%)
B.O.D.	717.8	29.84	13.34	85.99	31.28
C.O.D.	1486	2.38	1.064	84.64	29.09
T.D.S.	1507	106.2	47.51	46.05	12.48
T.S.S.	371.5	9.884	4.420	52.41	21.72
T.S.	1879.1	271.34	121.34	98.46	34.20
Sulphate	1252.7	27.059	15.622	79.59	9.070
Chloride	254.32	2.9279	1.4639	84.47	22.99



The reduction percentage by *Eichhornia crassipes (water hyacinth)* the mean of B.O.D., C.O.D., T.S., Sulphate and chloride are 31.28 % , 29.09% , 34.20% , 9.07%



and 22.99% respectively. Water hyacinth (*Eichhornia crassipes*) and two algae (*Chlorodesmis* sp. and *Cladophora* sp.) found reducing organic pollution in arsenic enriched wastewater of different concentrations (Jasrotia and Kansal, 2015).

5. CONCLUSION:

Dairy effluent nature is slightly alkaline, high temperature, unpleasant rancid odours, bitter or medicinal taste, hard, scaly deposits etc. when it is disposed without treatments it may results in adverse effects in fish growth, reproduction and immunity in water bodies, harmful effect on beneficial microorganism's and plant growth due to decrease micronutrients solubility, serious problems of health and hygiene, eutrophication.

Anaerobic activated sludge treatment followed by aerobic activated sludge treatment reduces the BOD, COD, TS, Sulphate, Chloride and BOD **:** COD ratio are 86%, 87%, 96%, 75%, 89% and 0.99 **:** 1 respectively. Treatment using *Eichhornia crassipes (water hyacinth)* showed the percent reduction in BOD, COD, TS, Sulphate, Chloride by 31%, 28%, 35%, 8%, 22% respectively which is relatively greater reduction percentage and covers the safe disposal standards of dairy effluent for irrigation purpose. But further study is necessary to carry out for any harmful effect of this treated effluent on the environment.

Treated effluent can be used for irrigation purpose and thus the waste water is recycled and also resolves the water pollution problem which affects the health and hygiene.

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