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The Effect of Tertiary Treated Dairy Wastewater on Fish Growth (A Case-Study Conducted at Katraj Dairy Pune)

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Abstract - *Dairy industry possess an important role in the state's economy perspective for agricultural sector in developing country like India. The waste water generated by this dairy industry contains effluents in the form of fats, dissolved sugars and Protein. Therefore, dairy untreated waste water is considered as high concentrated organic matter with high Biochemical Oxygen Demand (BOD) and contribute to pollution of land, river. These high concentration of organic matter and BOD in daily effluent becomes a noticeable problem for Katraj Dairy since 2018 according to the literature data. This present study has been prepared to evaluate Effluent Treatment Plant's impact on the growth of the fish used for treatment of the waste water. The aim of present research work is to determine suitability of treated dairy waste water and bring in to reuse and that treated water is used in fish tank to survive aquatic life. Samples from dairy waste water were collected from inlet chamber, aeration tank, equalization tank, clarifier outlet. Effluent Treatment plant (ETP) Pollution load is estimated by testing parameters such as Dissolve Oxygen (DO), Chemical Oxygen Demand (COD), Biological Oxygen Demand BOD, Mix Liquor Suspended Solid (MLSS), Total Dissolved Solid (TDS), Total Suspended Solid (TSS), Oil and Grease. It was observed that, the BOD, COD, TDS and TSS removal efficiency of ETP was within permissible limit as per Indian Standard. Also this treated water can be used for gardening and vehicle washing purpose imparting enviro-friendly solution to the industry.*

Key Words: *Dairy Industry; Effluent Treatment Plants; Environmental Problems; Economic viability*

1. INTRODUCTION

Dairy industry contains high volume of organic constituents in terms of organic matter with high Biochemical Oxygen Demand (BOD). These generated waste water is basic need to provide waste water treatment before discharging it into the natural water stream. These treatment mostly classified as aerobic and anaerobic process. Rapid growth in the population and their demand for various industries makes an adverse impact on environment in terms of pollution (A. S. Sutar et.al. 2015). Increase demand in quality of milk and milk products contribute to White Revolution in India. The dairy industry effluent (i.e. waste water) management is a major problem due to increase in the demand. Literature study showed that, the dairy Industry generates about 0.2–10 litters of waste water effluent per litre of processed milk being average of about 2.5 litters of waste water effluent (M. Wani et.al. 2017).

In Pune Zillaha Sahakari Dudh Utpadak Sangh Maryadit is a district level co-operative organization established in 1960, popularly known as 'Katraj Dairy' for processing milk and milk products. The representatives in this industry are mainly farmers based from rural areas to produce milk, encompassing almost from entire Pune District. The dairy industry is running on behalf of the milk producers for their socio-economic growth. Katraj Dairy started with milk collection of about 0.30 lakh (30,000) litters per day in the first year of operation and by present day it has increased to over 2.5 lakh (0.25 million) litre/day. Katraj Milk, Katraj Ghee, Katraj Shrikhand, Katraj Amrakhand, Katraj Lassi, Katraj Jeeratak (buttermilk), Katraj cream made are some leading food products in Katraj daily in Western Maharashtra (India). This industry is situated at Katraj, Pune (India) and process about 77781700 Litter/year total effluents (Katraj Dairy report 2019).

It was observed that dairy industries produce 1 to 2 litters of wastewater per litter of dairy milk processed food (Katraj Dairy report 2019). The dairy wastewater effluent possess highly variable nature in terms flow rates depending on the factory size and operation shifts. The pH, Suspended Solid (SS) content (mainly the result of the choice of cleaning strategy employed) are basic parameters to consider the effective wastewater treatment regime. Dairy industries generated waste mainly contains milk solids in a diluted condition with varying concentration. These solid particles enter in the waste material from all of the operations in industry. These soluble organic material, suspended solids and trace organic materials contribute heavily towards the five day high Biological Oxygen Demand (BOD5) and Chemical Oxygen Demand (COD). Generated dairy wastes are physically white in colour and slightly alkaline nature.

However, dairy waste becomes acidic at fast speed due to the fermentation of milk sugar to lactic acid at pH range varies from 4.0 to 11.0 Since this dairy waste waters possess highly biodegradable nature, it has to be effectively treated with biological wastewater treatment.

Basic objective of the present study is to evaluate effluent quality of Katraj dairy to survive aquatic life. The treated wastewater from dairy industry was used to evaluate the concept of fish growth to envisages the increase in its length, weight and survival time.

2. Material and Methodology

The Katraj Dairy plant possess an aerobic process on effluent mainly Primary, Secondary and Tertiary Treatment facility for primary check the pH at inlet, equalisation tank and treated water on hourly basis. Initially, Equalization tank shows pH in between 6 to 8 and it was dropped below 6 when water transferred into aeration tank. After pH drop below 6 the transfer of water was stopped and dissolved Caustic soda with fresh water in Bucket was added. This processed water is then sent to equalization tank and pH of equalization tank was noted. If the pH goes above 8 then stop the transfer of water into aeration tank and add Nitric acid in equalization tank. Wait for 15- 30 min for adjustment of pH to adjust between 6 to 8 otherwise adjust the quantity of Caustic Soda or Nitric Acid.

The treated waste water then processed for Activated Sludge process. This Activated Sludge process works effectively in pH range of 6-8 to improve chemical and biological Process. The range of pH have profound effect on the rate of microbial growth and affects the function of metabolic enzymes. Acidic conditions (i.e. low pH) or basic conditions (i.e. high pH) alter the structure of the enzyme and stop their growth. After maintaining pH of equalization tank the waste water transferred to aeration tank through adjusting flow with help of Inlet Flow meter (i.e. flow should be less than 18 m^3/hr-20 m^3/hr). After this treatment the waste water sent to secondary clarifier.

In the secondary clarifier a sludge tries to settle at the bottom and clear treated water from top was collected in the feed water tank. This collected water from secondary treatment was tested for pH, TDS, COD, BOD and readings were recorded daily. After that, this water was transferred to the tertiary system for Pressure sand Filter and Activated Carbon Filter. Finally treated water from filtration process was collected in the treated water tank. This treated water can be used for the gardening and vehicle Washing. The Species of Fish like *Catla* (Labeo *catla*) are added in this water to evaluate the growth rates of Fish. The weight of the species weighed time to time and recorded.

Some samples were collected from ETP at different sampling points and characteristics parameters such as BOD, COD, pH, TDS were calculated. The analysis was done by using APHA standard Methods.

2.1 Wastewater Treatment Facility at Katraj Dairy

Figure 1 represents the typical schematic diagram for Effluent treatment plant. Effluent treatment plant of capacity 300 KLD with peak factor 2 and it comprises with treatment units like Screen Chamber, Oil and Grease Trap, Equalisation cum neutralization tank, Aeration tank, Secondary clarifier I and II, Filter feed tank, Pressure sand filter, Activated carbon filter. To design treatment plant influent quality of Katraj Dairy is calculated as shown in Table 1.

Details of Effluent treatment plant units for capacity 300 KLD is tabulated in Table 2. Table 3 shows the design parameters Aeration tank, secondary clarifier, filter feed tank, pressure sand filter and activated carbon filter

Table 1: Influent quality of Katraj Dairy

Plant designed parameters	Quantity (mg/l)
BOD	1000
COD	1500
TSS	500
Oils and Grease	50-100
TDS	1500
pH	5.5-9.5

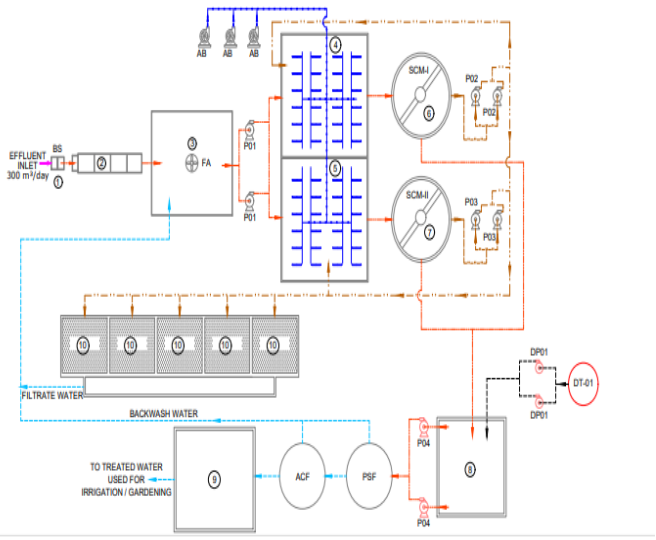

Fig. 1: Effluent Treatment Plant Scheme diagram

Table 2: Details of Effluent treatment plant units for capacity 300 KLD

Screen Chamber		Value	Unit
Design flow		600	KLD
Dimension of chamber		1.2 x 0.8 x 0.3 SWD	
Design flow		600	KLD
Detention time		15	Min
Dimension of chamber		1.25 x 6.25 x 1.2 SWD	Cu.m
Equalisation cum neutralization tank		Value	Unit
Design flow		600	KLD
Detention time		6	Hrs
Dimension of chamber		7.1 x 7.9 x 2.85 SWD	Cu. Mtrs.

Table 3: Design parameters of various filtration units

Aeration tank I & II	Value	Unit
Design flow	300	KLD
Dimensions	16 x 16 x 3.05	Cu.m
Blower capacity	1536	m3/hr
Secondary clarifier I & II		
Design flow	150	KLD
Dimension	5.5 m Dia. x 2.5 m	Cu.m
Filter feed tank	Value	Unit
Design flow	300	KLD
Detention time	6	Hr
Dimensions	6.43 x 6.43 x 2.5 SWD	Cu.m
Pressure sand filter	Value	Unit
Design flow	300	KLD
Dimensions	1.2 m x 2 m	Sq.m
Activated carbon filter	Value	Unit
Design flow	300	KLD
Dimensions	1.2 m x 2 m	Sq.m

3. Result and discussions

Treated water quality will be discharged in natural sources and in these sources aquatic life is present, therefore the ultimate aim of treatment is to survive aquatic life and grow of aquatic life in treated water. Here treated dairy waste water utilised for fish tank and check survival of aquatic life. The Species of Fish *Catla* (Labeo *Catla*) is used in the study. The Effluent treatment process resulted in an overall removal efficiency of 97% of BOD, 83.33% of COD, 80% of TSS, 86.87% of Oil and Grease. Table 4 represents the Effluent quality achieved for plant outlet after secondary clarification.

Table 4: Effluent quality

Plant outlet designed parameters after secondary clarification	**Values**	**Unit**
BOD	30	mg/l
COD	250	mg/l
TSS	100	mg/l
Oils and Grease	10	mg/l
TDS	2100	mg/l
pH	6.8-7.5	

Plant outlet designed parameters after secondary clarification	**Values**	**Unit**
BOD	<30	mg/l
COD	<250	mg/l
TSS	<30	mg/l
Oils and Grease	<10	mg/l
TDS	2100	mg/l
pH	6.5-7.5	

Result of ETP waste Water analysis

It has been seen that pH of the Treated Water within MPCB standard which is 5.5 to 9.0 mg/lit. The tank pH level for different period is shown in Figure 2. It is seen that COD of the Treated Water within MPCB standard which is 250 mg/lit. The tank COD level for different period is shown in Figure 3. It is seen that BOD of the Treated Water within MPCB standard which is 30 mg/lit. From Figure 4 and Figure 5 shows the tank BOD and Tank TDS of the Treated Water within MPCB standard which is 2100 mg/lit respectively.

The study has proven the growth of fish species in treated water. The Periodical growth of fish species grown length and weight in this treated water is tabulated in Table 5. The growth of fish species in terms of the average length and the average weight was noted for different period. From Figure 6 and Figure 7 it was observed that the average length and the average weight of fish species were increased with time.

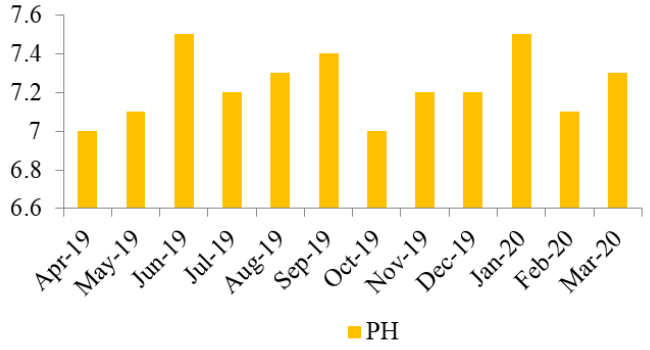

Fig. 2: Tank pH level

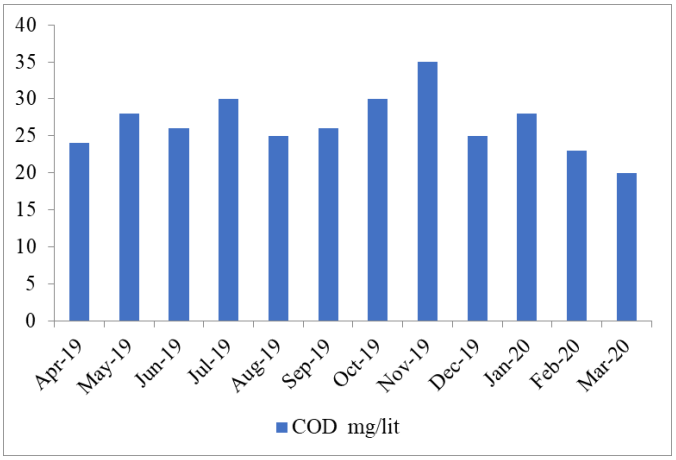

Fig. 3: Tank COD level

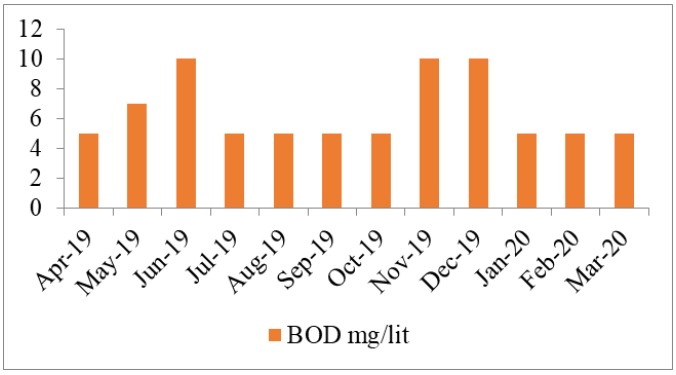

Fig. 4: Tank BOD level is given in following chart

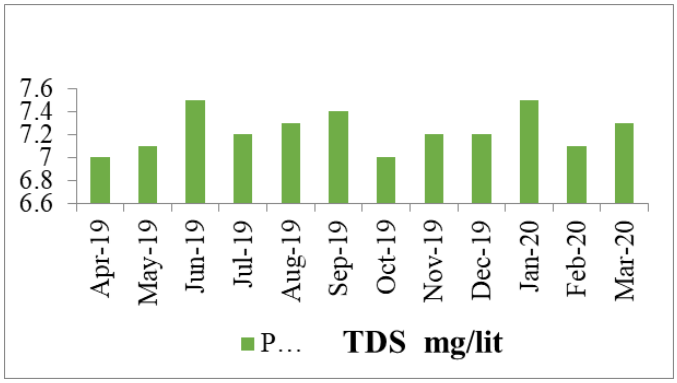

Fig. 5: Tank TDS level is given in following chart

Age of the fish in Months	Average Weight of the fish (gm)	Average Length of the fish (cm)
31/08/2018	2	2
17/10/2018	26	5
12-12-2018	190	9
02-02-2019	350	14
26/03/2019	400	18
27/05/2019	480	22
21/07/2019	576	26
19/09/2019	785	28
10-10-2019	900	30
14/12/2019	1100	33
24/02/2020	1300	35
25/03/2020	1500	38

Table 5: Periodical growth in length and weight of the fish grown in this treated water.

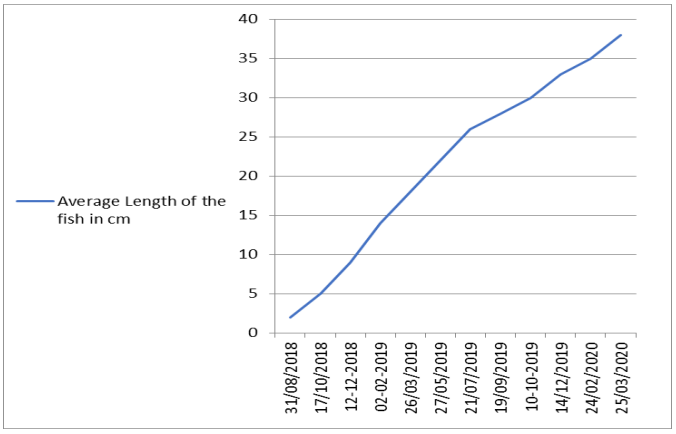

Fig 6: Average Length of the fish in cm

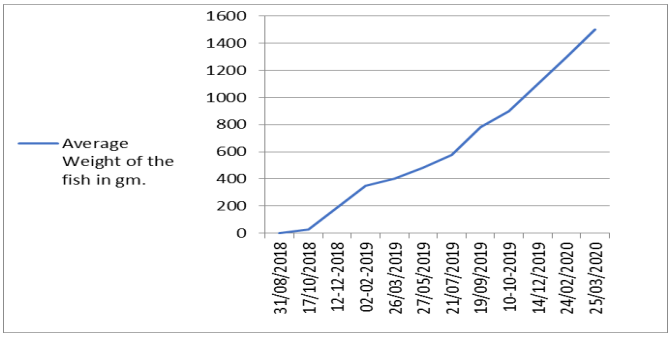

Fig. 7: Average Weight of the fish in gm

Dissolved Oxygen is necessary parameter for many living things in water including fish, invertebrates, bacteria and plants. These species organisms use oxygen for their respiration like organisms living on land. Fish and crustaceans use oxygen for their respiration process through their gills. Whereas plant life and phytoplankton demands dissolved oxygen for their respiration system in the absence of light for photosynthesis (fondriest, internet source). The amount of dissolved oxygen required for different species varies from creature to creature. Bottom feeders, crabs, oysters and worms requires very few amounts of oxygen (i.e. 1-6 mg/L), whereas fishes in shallow water required higher level of Dissolved Oxygen (i.e. 4-15 mg/L) [5].

Dissolved oxygen (DO) is one of the most important parameter to determine the quality of water. This dissolved oxygen is necessary for the survival fish species and other aquatic organisms. Comparatively higher amount of oxygen gets dissolves in shallow surface water due to the aeration process of winds. This dissolved oxygen observed to be quite low for fish species and other aquatic organisms to survive. Tank DO level is given in following Figure 8.

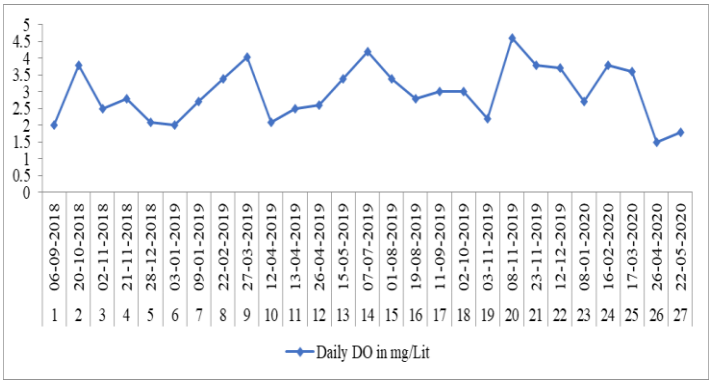

Fig. 8: Daily DO level Chart

It is seen that achieved parameters are useful to grow aquatic life in treated wastewater with maintaining dissolved oxygen level in the tank. Fish size is grown from 2 cm to 30 Cm and weight of fish is increasing from 2 gm to 1.8 Kg this is very good indication of maintaining Effluent quality regularly and further this fish is used for animal feed making.

4. Conclusions

1. The treated water has reduced the consumption of fresh water intake requirement from Pune Municipal Corporation for washing vehicles, milk cans and aesthetics gardening purpose in the dairy industry.
2. In the Current Study We examined the effect of Tertiary Treated Waste Water on *Catla (Labeo catla)* growth is found Satisfactory. The fish produced is also used in for animal food industry being calcium rich food.
3. Achieved ETP Treated Water parameter are useful to grow aquatic life and also survived for a period more than one and half year.
4. The entire project's economic viability has proved that there is little surplus to the dairy. Since we had decided to limit the scope of this paper on the effect of tertiary treated water on the growth of fish.
5. The present study had no adverse effect on Katraj Dairy economic viability while conducting the project.

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Author declaration

1. Conflict of Interest

There is no conflict of interest exists.

2. Funding

There is not any funding was received for this work.

3. Research Ethics

We further confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

4. Authorship

We confirm that the order of authors listed in the manuscript has been approved by all named authors.

5. Contact with the Editorial Office

We understand that this Corresponding Author is the sole contact for the Editorial process. He/she is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs. The Corresponding Author declared on the title page of the manuscript is:

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