TREATMENT OF DAIRY INDUSTRY WASTE WATER USING FUNGAL CONSORTIUM

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Abstract - *The effluents from dairy industry contain soluble organics, suspended solids, trace organics, thus having high BOD and COD. Biological treatment offers an economical alternative to physico-chemical treatment. Dairy effluent is inoculated with fungal consortium prepared by mixing two fungal species such as aspergillus and alternaria. The BOD, COD, Turbidity values are noted for 1, 3, 6, 9, 12 day of incubation for dairy effluent. BOD, COD reduction by the consortium is 85% and 78% after 12 day of incubation for dairy effluent. BOD, COD reduction by the consortium is 85% and 78% after 12 day of incubation for synthetic waste water. Values from dairy effluent and synthetic waste water show that lab condition and field condition are same. Thus the addition of innoculam of microorganism of fungus will increase the degradation process in biological treatment.*

Key Words: **fungal consortium, dairy effluent, BOD, COD**

1.INTRODUCTION

The release of various unwanted substance to the environment by the industries damages health and resource. India ranks first among the milk producing countries. Dairy industry is the main contributor to water pollution. The dairy industry wastewater are generated primarily from the cleaning and washing operations in the milk processing plants and is estimated to be 0.2-10 litres of effluent per litre of the milk processed milk with an average generation of about 2.5 litres of waste water per litre of the milk processed [16,17]. The dairy industry involves processing raw milk into products such as consumer milk, butter, cheese, yogurt, condensed milk, dried milk (milk powder), and ice cream, using processes such as chilling, pasteurization, and homogenization[13]. Due to high pollution load of dairy wastewater, the milk- processing industries discharging untreated/partially treated wastewater cause serious environmental problems [7]. Nutrients present in dairy effluent such as nitrogen lead to eutrophication of receiving waters [11].Dairy raw wastewater is characterized by high concentrations and fluctuations of organic matter and nutrient loads [6]. The composition varies depending on the operations and products [9]. The waste water of dairy contain large quantities of milk constituents such as casein, lactose, inorganic salt, besides detergents and sanitizers used for washing [10]. Some physico-chemical processes have been implemented for the treatment of dairy effluent such as osmosis membranes [2,5], ultrafiltration [14] or electrochemical treatment[11]. The limitations of physicochemical methods including partial treatment, higher cost, and generation of secondary pollutants, higher quantity solids and use of chemicals agents, which make the biological methods a favourable alternative for the removal of pollutants [15].But in biological treatment large amount of sludge generated and the cost of excessive sludge treatment is a major problem. The addition of microorganism with high degradation ability will reduce the sludge problem. Fungi are recognized for their superior aptitudes to produce a large variety of extracellular proteins, organic acids and other metabolites, and for their capacities to adapt to severe environmental constraints [3,12].Studies have shown that mixed cultures of fungi enable a greater production of enzymes responsible for the degradation of organic matter [4].

Amanpreet Kaurand [1] studied the potential of free and immobilized fungal isolates to treat the dairy wastewater at different concentrations of dairy effluent. Five fungal sp. D1W & D4S (*Alternari*a sp.), D3S (*Fusariu*m sp.), D2W & D5S (*Aspergillus* sp.) were isolated from dairy effluent sample. Free and immobilized spores were inoculated in different concentrations of dairy effluent and incubated and the efficiency is compared. Free cells of all fungal isolates of summer season had shown the potential of reducing COD at different concentrations of D.E

Hayet Djelal [8] focused on the efficiency of a fungal consortium including *Aspergillus niger*, *Mucor hiemalis* and *Galactomyces geotrichum* for the treatment of dairy wastewater. The positive impact of fungal addition was confirmed when fungi was beforehand accelerated by pre-culture on whey (5 g/L lactose) or on the dairy effluent.

The purpose of the study is to compare the reduction rate of BOD, COD, and turbidity for dairy effluent after the addition of fungal consortium in lab scale batch culture.

2. MATERIALS AND METHODS

2.1 Media

Two culture media were tested. Dairy waste water provided from Ambalathara dairy industry Trivandrum. Samples of raw waste water were taken from secondary settling tank. It is collected in sterile plastic container and stored at 4^oC for further investigations. A synthetic dairy waste water prepared by mixing glucose 90 mg, yeast 10 mg, milk powder 1500 mg, starch 5 mg, ammonium chloride 50 mg, di potassium hydrogen phosphate 25mg, di hydrogen potassium phosphate 15 mg, magnesium sulphate 80 mg, calcium carbonate 30 mg in 1ltre of distilled water. The characteristics of dairy effluent and synthetic waste water are given in the table 2.1,2.2

.**Table -2.1:** Characteristics of Dairy waste water

Sl No.	Parameter	Value
1	pH	5.37
2	Turbidity (NTU)	391
3	BOD (mg/L)	1150
4	COD (mg/L)	1600
5	Total solids (mg/L)	17
6	Total dissolved solids (mg/L)	11
7	Total suspended solids (mg/L)	6
8	Total Fixed solids (mg/L)	10
9	Nitrate (mg/L)	22

Table -2.2: Characteristics of Synthetic waste water

Sl No.	Parameter	Value
1	pH	6.91
2	Turbidity (NTU)	404
3	COD (mg/L)	2400
4	BOD (mg/L)	1200
5	Total solids (mg/L)	18
6	Total suspended solids (mg/L)	14
7	Total dissolved solids (mg/L)	4
8	Total fixed solids (mg/L)	10
9	Total volatile solids (mg/L)	8

2.2 Biological characteristics

To count the number of fungal colonies in the waste water, serial dilution followed with pour plating was done. Three samples were prepared after serial dilution to 1/10, 1/100, 1/1000, 1/10000 and from each sample one ml sample is poured into a petri plate and add 9 ml of PDA medium and is well mixed and incubated. After incubation, the colony forming units of fungus were noted in petri plates and is shown in the figure 2.1

No of colonies= 30000 CFU/ml

2.1 Fungal colony in dairy effluent

2.3Microorganism

To prepare consortium the fungal species were purchased from MCC Pune. The species such as *aspergillus* and *alternaria* were used and it is collected in the form of freeze dried culture.

2.4Consortium preparation

Potato dextrose agar medium is prepared by mixing 20 g dextrose, 4 g potato extract and 15 g of agar in 1000 ml distilled water. The pH of medium is adjusted in the range of 5.5-6.5. The agar slant is prepared by transferring PDA medium to test tube and is kept in slanting position for 30 minutes. Fungal cultures of *aspergillus* and *alternaria* streaked in the test tube and are incubated. Growth of culture is noted. The PDB medium is prepared by boiling 200 g potato in 1000 ml distilled water. The remaining filtered water is mixed with distilled water to make 1000 ml.20g glucose is also added. The pH of medium is adjusted to 5.6. Culture is streaked in PDB medium and is incubated at 30-35^oC. The growth is noted after incubation for both species. 250 ml of PDB medium is streaked with *Aspergillus* sp. and *Alternaria* sp. and it is incubated for 35^0C 24 hours.

Fig 2.2 Cultures of a*spergillus and alternaria* in PDA medium

Fig 2.3 Agar slant of *alternaria* and *aspergillus*

Fig 2.4 Cultures of a*spergillus and alternaria* in PDB medium and fungal consortium

2.5Biodegradation using fungal consortium

Consortium in the PDB medium inoculated with 10 % of dairy effluent. The sample is acclimatized for 15 days. After acclimatization the culture is transferred to a dairy effluent of 250 ml and is incubated. After incubation the BOD, COD, turbidity values noted for 1, 3, 6, 9, 12 days for both dairy waste water and synthetic waste water.

2.6Physico-chemical analysis of dairy effluent

The 5 day BOD was determined by using titration method, COD was estimated by the reflux method described in the standard methods for examination of waste and waste water. Turbidity was determined by turbidimeter.

3.RESULTS AND DISCUSSIONS

3.1 BOD reduction by fungal consortium

BOD values for dairy effluent and synthetic waste water after 12 day of incubation is shown in the above table 3.1 and the variation of BOD is shown in the above graph 3.1,3.2

Table 3.1: BOD variation for dairy effluent and synthetic waste water in mg/L

Sl No	Days	Dairy waste water	Blank	Synthetic waste water	Blank
1	1	1000	1050	1050	1000
2	3	950	1000	900	1000
3	6	650	950	450	950
4	9	550	750	250	850
5	12	150	350	100	350

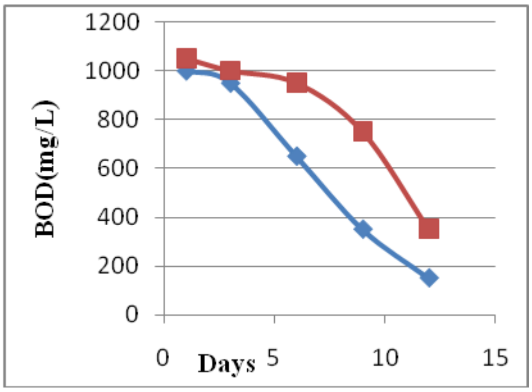

Fig 3.1 Variation of BOD for dairy effluent and blank

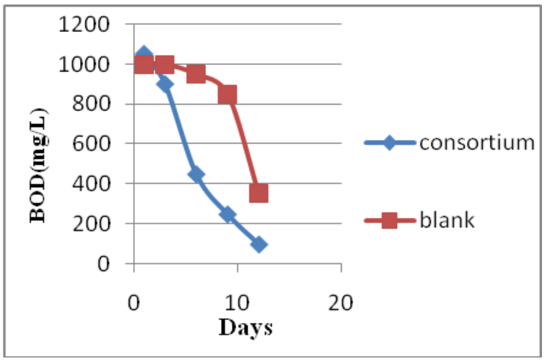

Fig 3.2 Variation of BOD for synthetic waste water and blank

3.2 COD reduction by fungal consortium

COD values for dairy effluent and synthetic waste water after 12 day of incubation is shown in the above table 3.2 and the variation of COD is shown in the above graph 3.3,3.4

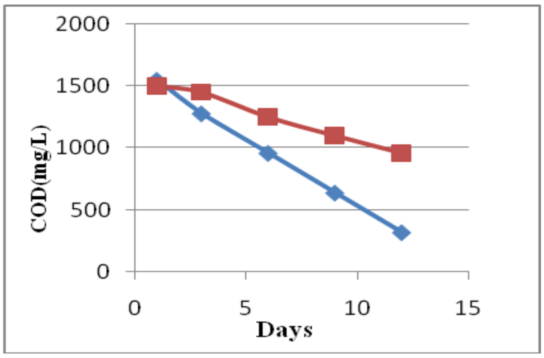

Fig 3.3 Variation of COD for dairy effluent and blank

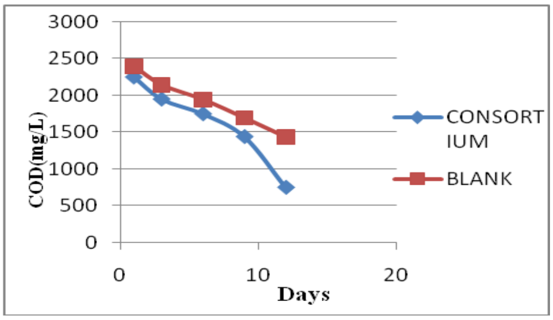

Fig 3.4 Variation of COD for synthetic waste water and blank

Table 3.2: COD variation for dairy effluent and synthetic waste water in mg/L

Sl No.	Days	Dairy	Blank	Synthetic	Blank
1	1	1550	1500	2250	24000
2	3	1280	1450	1950	2150
3	6	960	1250	1750	1950
4	9	640	1100	1440	1700
5	12	320	960	750	1440

3.3 Turbidity reduction by fungal consortium

Turbidity values for dairy effluent and synthetic waste water after 12 day of incubation is shown in the table 3.3 and the variation of Turbidity is shown in the figure 3.5,3.6

Table 3.3: Turbidity variation for dairy effluent and synthetic waste water in mg/L

Sl No	Days	Dairy	Blank	Synthetic	Blank
1	1	388	386	400	398
2	3	251	380	391	395
3	6	225	376	376	378
4	9	210	344	358	370
5	12	175	315	298	365

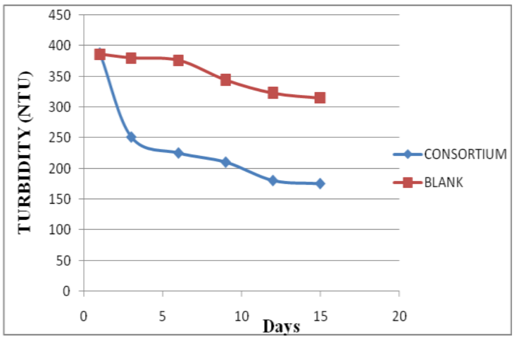

Fig 3.6 Variation of Turbidity for Dairy waste water and blank

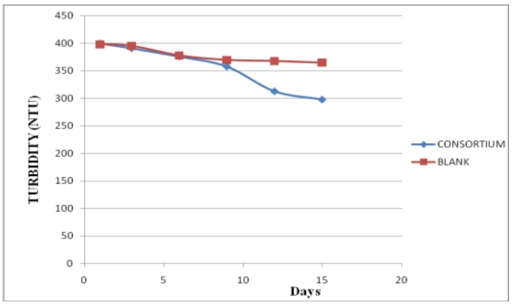

Fig 3.6 Variation of Turbidity for Synthetic waste water and blank

3.4 Biodegradation of dairy waste water

The variation of BOD for blank and consortium is linear up to third day of incubation. After third day, the reduction of BOD of consortium is more than the blank. After 12th day of incubation the percentage reduction of BOD for dairy effluent is 85 % and for blank it is 67 %. The reduction in BOD is mainly by mycoremediation. Fungi increase the degradation of both organic and inorganic substrates and it can convert the undesirable material into harmless products. Thus after the fungal consortium addition the amount of organic matter reduced. The reduction of COD for fungal consortium is very high compared to blank. The percentage reduction of COD of dairy effluent is 80 % and for blank it is only about 36 % reduction. The degradation of the organic, inorganic substance in waste water by fungi is the reason for the reduction of COD. Fungi have the ability to degrade organic compounds such as lipids, proteins and carbohydrates suspended solids which is responsible for high level of COD. The reduction of turbidity by fungal consortium in dairy effluent is high compared to the blank. A sudden change of turbidity occurred from first day to third day of incubation. After third day of incubation of consortium the reduction rate is less. The percentage reduction of turbidity is 56 % and for blank it is only 20 %

3.5Biodegradation on synthetic dairy waste water

The variation of BOD for synthetic waste water with consortium is very high as compared with the blank. The reduction for synthetic waste water is 91 % and for blank it is 65 %.COD reduction for blank and consortium is almost similar up to 6 days for synthetic waste water. The reduction is 67 % for synthetic and 40 % for blank. In synthetic waste water the reduction rate of turbidity is very less. Up to 9 day of incubation the reduction rate were almost similar for sample and blank. The reduction rate of turbidity for synthetic waste water is 27 % and its blank have a reduction of 10 %.

4. CONCLUSIONS

The efficiency of degradation of dairy effluent by the consortium of *aspergillus* and *alternaria* was examined. BOD, COD reduction by the consortium is 85 % and 78% after 12 day of incubation for dairy effluent. BOD, COD reduction by the consortium is 91 % and 67% after 12 day of incubation for synthetic waste water. Thus reduction of BOD, COD in lab and field condition is almost same and is safe for disposal. By the addition of fungal consortium a higher reduction rate of turbidity is obtained for both dairy effluent and synthetic waste water. Mycoremediation using fungus is suitable for the treatment of dairy effluent. Thus the treatment of dairy waste water using fungal consortium prepared by mixing two fungal species gives a better reduction in BOD, COD, turbidity both in lab and field condition.

The treatment using fungal consortium can be used for various other species of fungi and can be done in an industrial scale. A tertiary treatment could be proposed to finalize the biological treatment of industrial effluents, which appear however expensive, contrarily to the proposed bioaugmentation by the addition of a fungal consortium.

REFERENCES

[1]. Amanpreet Kaurand Sonia Chaman (2014), "Dairy wastewater treatment by free and immobilized fungal isolates" , Journal of Microbiology and Biotechnology Research 31-37

[2]. Balannec B, Vourch M, Rabiller-Baudry M, Chaufer B, (2005)," "Comparative study of different nanofiltration and reverse osmosis membranes for dairy effluent treatment by dead end filtration". *Separation Purification Technology*, 42(2):195–200.

[3]. Cochrane VW. Physiology of the Fungi. John Wiley and Sons Inc.,New York. 1958.

[4]. Deepak D, Anand K V, Bhargarva R, 1994. "Biodegradation kinetics of metal cutting oil: evaluation of kinetic parameters". *The Chemical Engineering Journal and the Biochemical Engineering Journal*, 56(1): B91–B96.

[5]. Del Re G, Di Giacomo G, Aloisio L, Terreri M, (1998), "RO treatment of waste waters from dairy industry". *Desalination*,119 (1-3): 205–206.

[6]. B.Farizoglu,S.Uzuner(2011), "The investigation of dairy industry waste water treatment in a biological high performance membrane system",BiochemEngJ.57, 46–54.

[7]. S.G.Ganapathy, R.Bhaskaran, P.M.Mohan (2011), Microbial diversity and bioremediation of distilleries effluent, J.Res.Biol 3,153-162

[8]. Hayet Djelal1, Abdeltif Amrane (2013), "Biodegradation by bioaugmentation of dairy wastewater by fungal consortium on a bioreactor lab-scale and on a pilot-scale" , Journal of environmental sciences 25(9) 1906–1912

[9]. A.S.Khojare, M.R.Patil, A.R.Sarode, P.G.Wasnik (2002). "Memmbrane process: An emerging solution for effluent treatment in dairy and food plant" Proceedings of UGC Sponsered National Conference on 'Hydro-chemical, Bio –chemical Studies and Enviornmental pollution' Aurangabad

[10]. A.S.Kolhe, S.R.Ingale, R.V Bhole, Effluents of dairy technology (2009), Int.Res.Jr. Sodh, Samiksha and Mulyankan 5,459-461

[11]. J.P.Kushwaha, V.C.Srivastavva, I.D.mall, (2010), "An overview of various technologies for the treatment of dairy wastewaters",Crit.Rev.Food Sci.Nutr.51,442-452

[12]. Lilly VM, Barnett HL. Physiology of the Fungi. McGraw-Hill BookCo., 1st ed. New York, New York. 1951.

[13]. Loperena L, Saravia D, Murro C, Ferrari M D, Lareo C, (2006). "Kinetic properties of a commercial and a native inoculums for aerobic milk fat degradation". *Bioresource Technology*, 97(16): 2160–2165.

[14]. Luo J Q, Ding L H, Qi B K, Jaffrin M Y, Wan Y H, (2011). "A two stage ultrafiltration and nanofiltration process for recycling dairy wastewater". *Bioresource Technology*, 102(16): 7437–7442

[15]. H.J. Porwal, A.V.Mane, S.G.Velhal (2014) "Biodegradation of dairy effluent by using microbial isolates obtained from activated sludge" , Water Resources and Industry, 9,1–155

[16]. Ramaswamy, E.V.,Gajalekshmi, S.,Sanjeevi, R., Jithesh, M.N.,and Abbasi, S.A. (2004). "Feasibility

studies on the treatment of dairy waste waters with upflow anaerobic sludge blanket reactors." *Bioresource Technol.* **93**:209-212

[17]. Ramaswamy, E.V. and Abbasi S.A. (2000). "Energy recovery from dairy waste waters: Impact of biofilm support on anaerobic CST reactors". *Appl Energy* 65:91-98