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Utilization of algal biomass for bio-remediation of effluent water from oil blending plant

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Abstract

High level of oil and grease, elevated COD (chemical oxygen demand) and inorganic waste in effluent from oil blending plant can cause contamination of ground water and can even cause removal of vegetation in the area. *Spirulina platensis* was cultivated in the effluent and remarkable decrease in pollution load was observed with respect to COD reduction. Batch culture experiments show a reduction upto 70-95%. Efficiency of COD reduction improves as steady state is provided to the system.

Introduction

Effluent from oil blending plant has a high COD load(*Ref TABLE 1*). Such effluent if discharged directly to the aquatic water bodies will cause damage to aquatic life and deteriorate the water quality due to its high COD load.

Algae like spirulina can utilize the components present in the effluent water and thus reduce the pollution load of the water. Effluent received from oil blending plant can support the growth of spirulina and can help in generating valuable spirulina biomass.

TABLE 1. The physical and chemical characteristics of the effluent water is described in the following table

Sno	Characteristics	Observed values
1	Colour	Light brown
2	pH	14
3	temperature	33 deg C
4	Total suspended solids (mg/lit)	1000
5	Total dissolved solids (mg/lit)	24,000
6	Oil and grease(mg/lit)	350
7	Chemical oxygen demand(mg/lit)	28800
8	Biological oxygen demand (mg/lit)	5000

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Materials and methods

CULTURE: *Spirulina platensis* CCC 147. It was maintained and grown on zorrouk medium.

PREPARATION OF MEDIUM: The Effluent water was first given primary treatment to reduce the suspended particles. Primary treatment of water also reduces the colour of the effluent, thereby allowing penetration of sunlight deep into the media thus the grow the algae increase as favourable condition is maintained. Different basal media are prepared in which effluent was incorporated as the major ingredient.

The pH of the media plays an important role in providing the optimal condition for the cultivation of spirulina. pH is adjusted using 1N NaOH to 10. The water is then inoculated with spirulina culture and then incubated at 35 deg C under natural light (5-7 Klux) with 2 – 4 times stirring per day.

Tests were performed every 24 hrs and using standard methods. Water quality was judge by the reduction of COD, which was performed as per standard APHA method. Growth of spirulina was estimated using different parameters like pH, optical density, dry weight and chlorophyll.

Results and discussion

Different growth media were prepared for the cultivation of spirulina. The main ingredient of the media was primary treated effluent. There were media which did not consist of any external supply of chemical but the algae was allowed to grow on the nutrients available in the water. The media was sometimes supplemented with varying quantity of sodium bicarbonate. The water with high COD load could not support the growth of spirulina. Even the water with dark colouration was not suitable for the cultivation of spirulina due to shading and reduction in light transmission.

pH of the media plays an important role in the growth of spirulina. Media with a pH level of 7-8 could not provide a favourable condition whereas pH of 10 was the best condition for the maximum cultivation of *Spirulina platensis(Refer TABLE 2)* .

TABLE 2 : Effect of different pH on the removal of COD

COD reduction						
	pH 7.5 media		pH 8.4 media		pH 10 media	
Incubation period (days)	COD (ppm)	% reduction	COD ppm	% reduction	COD ppm	% reduction
0	7840		4920		6550	
1	6720	14.3	4928	0.0	3104	52.6
2	5600	28.6	2500	49.2	2172	66.8
3	5824	25.7	1792	63.6	1319	79.9
4	4032	48.6	1800	63.4	1288	80.3
5	3808	51.4	2464	49.9	931	85.8

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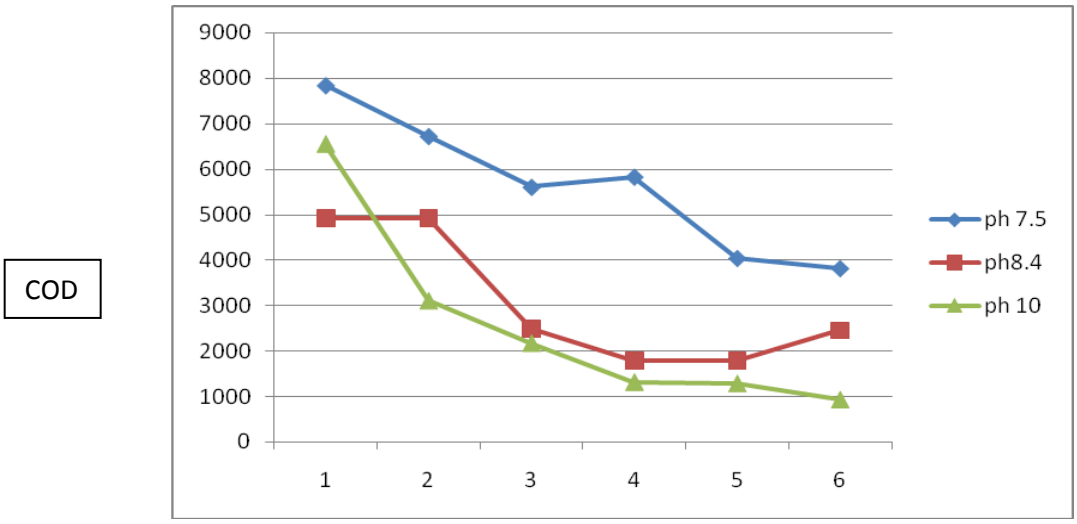
FIG 1 : COD at different pH



The maximum reduction in COD was observed in the media of pH 10 ie 85.8%. The optimum pH for the maximum growth rate of *Spirulina platensis* is observed to be 9.5. This was noticed when the culture was grown in standard media with and initial pH of 9.2. The growth declined as the pH on incubation reaches above 11.0. (*see TABLE 3*)

Fig 2: % Reduction wrt diff pH

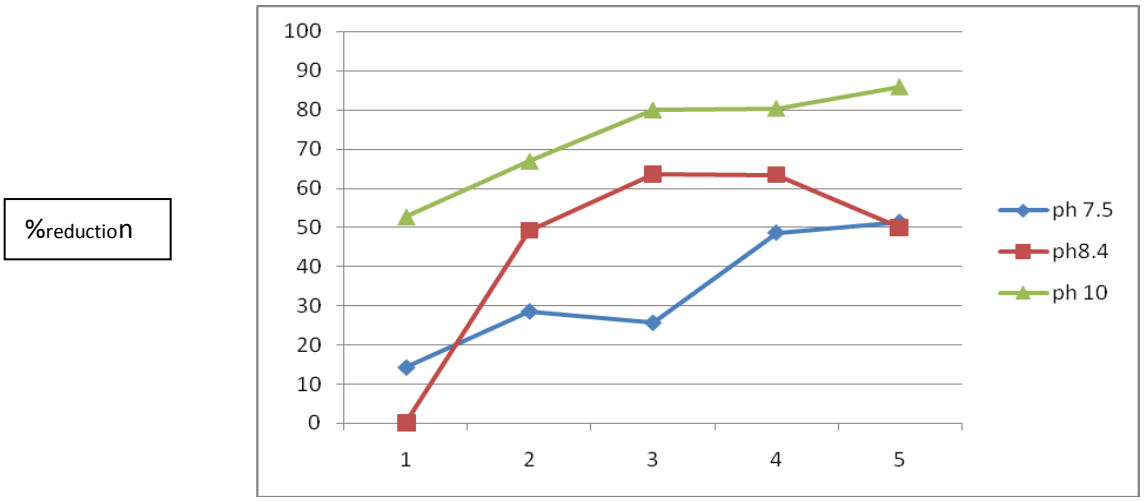


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TABLE 3: Effect of pH on growth of Spirulina platensis.

Incubation time (day)	Set - I		Set -II	
	pH	Optical density nm	pH	Optical Density nm
initial	9	0.381	8.9	0.245
2	9.2	0.531	9.2	0.435
4	9.7	0.76	9.7	0.669
6	9.7	1.082	9.7	0.88
8	9.8	1.322	9.8	0.97
10	9.8	1.66	9.8	1.125
12	10.9	1.11	11.0	0.775

Table 4 : Composition of zorrouk media and KVK medium

sno	ingredients	Zorrouk medium (gm)	KVK medium (gm)
1	NaHCO3	16.8	10
2	KNO3	2.5	_
3	NaCl	1	_
4	K2SO4	1	_
5	K2HPO4	0.5	_
6	CaCl2	0.02	_
7	FeSO4	0.01	_
8	MgSO4	0.2	0.2
9	Na EDTA	0.08	_
10	Trace metal mix	1	_
11	Suphala (15:15:15)		1

Effluent water was diluted using media of different composition and having different sources of nitrogen, phosphorus .Zorrouk media has a high carbon, nitrogen and phosphorus content as compared to KVK media (*see TABLE 4*). Spirulina utilizes the nutrients present in the effluent water thus requires a very less amount of supplements(*TABLE 5, TABLE 6 and FIG 3*).

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TABLE 5 : Effect of different media

sno	KVK MEDIUM (C:N:P=10:1:1)		ZORROUK MEDIUM (C:N:P=27:4:1)	
	COD	% reduction	COD	% reduction
1	3168		3400	
2	2613	17.5	1980	41.8
3	880	40.7	1980	41.8
4	1840	41.9	1940	42.9
5	1440	54.5	1840	45.9
6	932	70.6	1520	55.3

FIG 3 : reduction in COD using different media

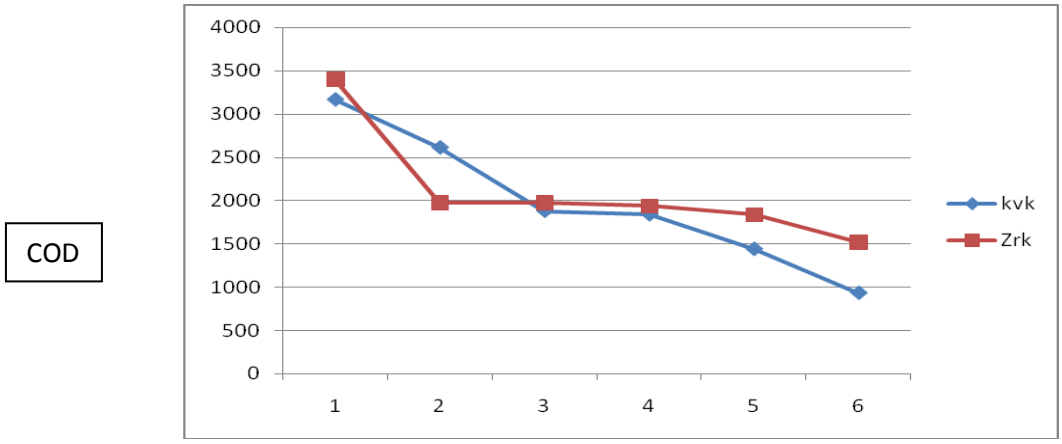

TABLE 6: concentration of components

Sno	Incubation time (days)	2% NaHCO3	4% NaHCO3	6% NaHCO3
		COD (ppm)	COD (ppm)	COD (ppm)
1	Initial	3485	3104	3627
2	2	1707	1941	1862
3	4	1552	1232	1686
4	6	776	1164	1474

Different species of *Spirulina platensis* were experimented for the reduction of COD. Diluted effluent sample was treated with two strains of Spirulina platnesis. One *Spirulina platensis* CC 477 source IARI, and second source : KVK Ahmednagar. *Spirulina platensis* source : KVK Ahmednagar reduced the COD of the diluted effluent sample upto 94.4% (*Refer TABLE 7and FIG 4 &5*).

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TABLE 7: Different species of spirulina used for the reduction of COD

		CULTURE: IARI				CULTURE: KVK			
SNO	**TIME OF INCUBATION**	**pH**	**CHLOROPYLL mg/lit**	**COD ppm**	**% reduction**	**pH**	**CHLOROPYLL mg/lit**	**COD ppm**	**% reduction**
1	INITIAL	9.5	3.22	2296		9.1	2.4	3215	
2	48 hr	9.8	3.47	1042	78.7	9.7	2.52	703	78.1
3	72 hr	9.8	3.77	490	54.6	9.9	3.62	328	89.8
4	96 hr	9.8	4.1	339	85.2	9.9	3.9	218	93.2
5	144 hr	9.9	6.2	164	92.9	9.9	7.1	164	94.9
6	216 hr	10	8.15	170	92.6	10	12.09	181	94.4

FIG 4 : COD reduction by different species of spirulina. No media addition

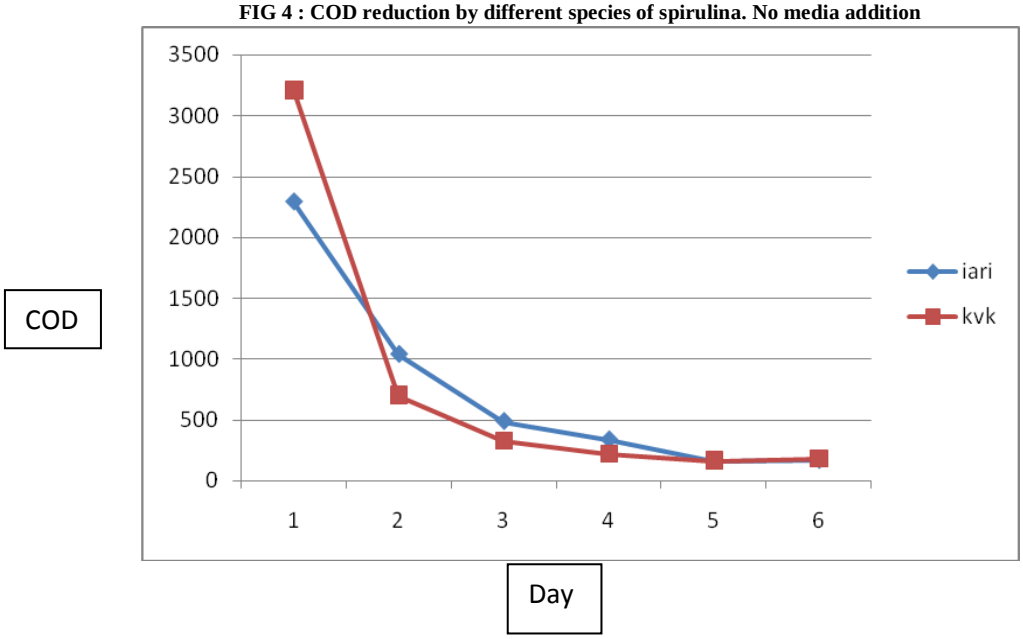

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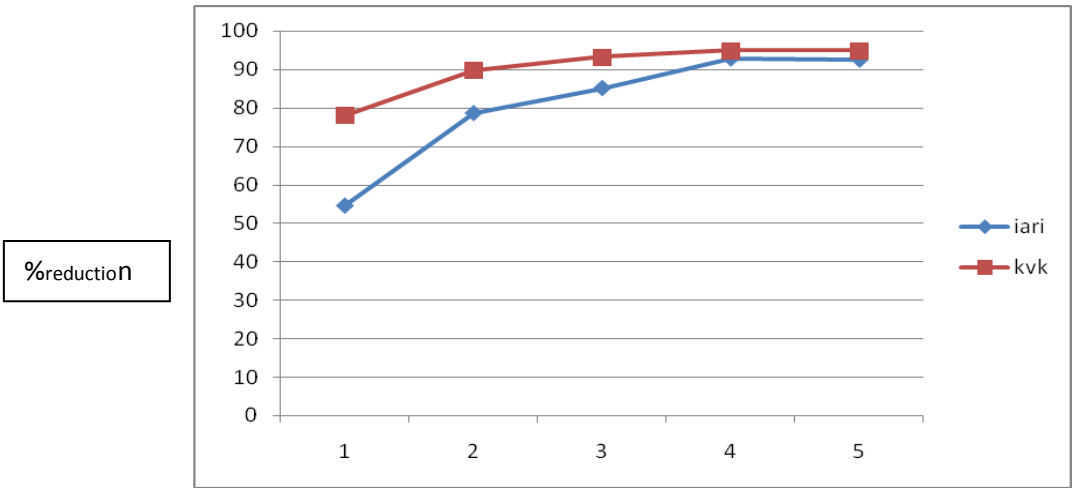
FIG 5 : %reduction of COD by different species of spirulina



Batch culture system was used to study the biotreatment of effluent water of different COD load. COD values upto 6500ppm was employed for the purpose(*TABLE 8*). The growth of the culture is measured as the content of chlorophyll increase in the suspension. The culture utilises the nutrients available in the effluent water successfully.

TABLE 8 : Reduction is also observed at higher COD levels. No media addition

SNO	TIME OF INCUBATION	pH	CHLOROPYLL mg/lit	COD ppm	% reduction
1	0 hr	9.5	1.52	6582	
2	24 hr	9.7	1.7	3571	45.7
3	48 hr	9.9	1.87	2063	68.7
4	72 hr	10	2.3	1111	83.1
5	96 hr	10.1	2.5	1130	82.8
6	168 hr	10.1	4.5	135	97.9
7	192 hr	10.1	4.6	171	97.4
8	216 hr	10.1	4.69	173	97.4

In batch culture system the harvesting is very important since that has an effect on the growth of the culture. As spirulina grows it tends to increase the pH .The increase in pH and the accumulation of the metabolic may reduce the growth rate.The excess growth has to be removed and fresh amount of effluent should be added in order to maintain a healthy culture.

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