Certificate of Publication

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | E-ISSN 2348-1269, P- ISSN 2349-5138

An International Open Access Journal

The Board of

International Journal of Research and Analytical Reviews (IJRAR)

Is hereby awarding this certificate to

Pravin Meshram

In recognition of the publication of the paper entitled

APPLICATION OF PHYCO-REMEDIATION TECHNIQUE IN THE TREATMENT OF TEXTILE EFFLUENT TO REDUCE POLLUTION LOAD

Published In IJRAR (www.ijrar.org) UGC Approved (Journal No : 43602) & 5.75 Impact Factor

Volume 7 Issue 3 , Date of Publication:July 2020 2020-07-23 02:32:54

PAPER ID : IJRAR19L1799

Registration ID : 223250

R.B.Joshi

EDITOR IN CHIEF

UGC and ISSN Approved - International Peer Reviewed Journal, Refereed Journal, Indexed Journal, Impact Factor: 5.75 Google Scholar

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS | IJRAR

An International Open Access Journal / Approved by ISSN and UGC

Website: www.ijrar.org | Email id: editor@ijrar.org | ESTD: 2014

IJRAR | E-ISSN 2348-1269, P- ISSN 2349-5138

IJRAR | E-ISSN 2348-1269, P- ISSN 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR)

An International Open Access Journal | Approved By ISSN and UGC

Ref No : IJRAR/Vol 7 / Issue 3/ 799

To,
Pravin Meshram
Publication Date 2020-07-23 02:32:54

Subject: Publication of paper at International Journal of Research and Analytical Reviews (IJRAR).

Dear Author,

With Greetings we are informing you that your paper has been successfully published in the International Journal of Research and Analytical Reviews (IJRAR) - IJRAR (E-ISSN 2348-1269, P- ISSN 2349-5138). Thank you very much for your patience and cooperation during the submission of paper to final publication Process. It gives me immense pleasure to send the certificate of publication in our Journal. Following are the details regarding the published paper.

About IJRAR	: UGC and ISSN Approved - International Peer Reviewed Journal, Refereed Journal, Indexed Journal, Impact Factor: 5.75, E-ISSN 2348-1269, P- ISSN 2349-5138
UGC Approval	: Journal No: 43602
Registration ID	: IJRAR_223250
Paper ID	: IJRAR19L1799
Title of Paper	: APPLICATION OF PHYCO-REMEDIATION TECHNIQUE IN THE TREATMENT OF TEXTILE EFFLUENT TO REDUCE POLLUTION LOAD
Impact Factor	: 5.75 (Calculate by Google Scholar) | License by Creative Common 3.0
DOI	:
Published in	: Volume 7 | Issue 3 | July 2020
Publication Date:	2020-07-23 02:32:54
Page No	: 318-324
Published URL	: http://www.ijrar.org/viewfull.php?&p_id=IJRAR19L1799
Authors	: Pravin Meshram, Savi Shende, Vaishali Meshram

Thank you very much for publishing your article in IJRAR. We would appreciate if you continue your support and keep sharing your knowledge by writing for our journal IJRAR.

R.B. Joshi

Editor In Chief
International Journal of Research and Analytical Reviews - IJRAR
(E-ISSN 2348-1269, P- ISSN 2349-5138)

SEVADAL MAHILA MAHAVIDYALAYA NAGPUR

Principal
Sevadal Mahila Mahavidyalaya
Umrer Road, Nagpur-9.

Application of Phyco-remediation technique in the treatment of Textile Effluent to reduce pollution load

[1]Pravin Meshram*, [2]Savi Shende, [3]Vaishali Meshram
[1]Associate Professor & Head, [2] Research Scholar, [3] Assistant Professor
[1&2]Dept. of Environmental Science, Sevadal Women's College & Research Academy Nagpur, Maharashtra, India.
[3]Dept. of Chemistry, M. P. Deo Memorial Science College, Nagpur, Maharashtra, India.

Abstract: Textile industries process are one of the water consuming and as a resultant generating large volume of wastewater containing organic and inorganic chemicals. This study has been undertaken to investigate the efficiency of phyco-remediation to treat textile effluent by using consortiums of BGA and Chlorophyta. The experiment was performed using textile effluent with a optimize dose of algae under laboratory conditions for 20 day. The result shows that both the algae, work effectively to remove the nutrient load from the textile effluent. The present paper covers, the phyco-remediation method applied, reduction efficiency obtained of both the consortium, comparison of treated effluents values with the permissible limits line-up by BIS and ISI standards.

Index Terms– **Phyco-remediation, Textile effluent, BGA, Chlorophyta, water & waste water.**

I. Introduction

The rapid growth of human population and indiscriminate use of natural resources, industrialization and quest for material comforts raised the water pollution problems. Additional to it, new life style demanding a variety of products and amenities, leading to degradation of water quality. The world is facing acute problems with a wide variety of water pollutants (1). Today the demand for clean water is increasing worldwide and the main challenge of proper and adequate facility of wastewater treatment is not only to produce clean water but it also supports the new developments (2).

The textile industry selected were highly water-intensive, consumes enormous quantity of water for their production. The water consumed during processing which is discharged as treated effluent was no longer under permissible limit. However it contains high amount of inorganic and organic compounds emanate from the material used during production. Currently used physico-chemical technologies are cost consuming, hence present study was selected to find efficient, eco-friendly and cost-effective phyco-remediation technique for treatment of textile effluent.

The present research work was applied by using novel consortium of Chlorophyta and Blue green algae for removing pollutants from textile industrial waste waters at laboratory scale for investigation.

II. Sampling

The sample of microalgae was collected from lakes present in and nearby Nagpur city. The four major water bodies of Nagpur city namely Ambazari, Gandhisagar, Futala and Sakkardara lake were selected for collection of algal species. The station or site was selected on the basis of availability of algae. The samples were collected into previously sterile plastic bottles of 1 lit. and brought immediately to laboratory for identification, isolation and incubation.

Morarjee Textile is one of the leading textile company in premium shirting fabric, high fashion printed fabric business. The effluent sample of Morarjee textile industry was collected directly from the outlet in 5 lit of sterile plastic containers to study the physico-chemical parameters and treatment at laboratory.

III. Analysis of Physico-chemical characteristics of effluent

The industrial effluent for physico-chemical characteristics were collected directly in pre-washed distilled water plastic containers for respective parameters. Stipulated procedure was followed for washing of sample container. The physico-chemical parameters included minerals and demand analyses were performed as per the procedures described in Standard Methods for the examination of water and waste water. The Standard Method for analysis of initial and final physico-chemical parameters of industrial effluents was referred from APHA and NEERI manual (APHA, 2000 and NEERI manual).

The raw effluents from selected industry were collected to estimate the efficiency of algal strains using phyco-remediation method. The initial physico-chemical parameters of the effluent were identified immediately once the sample brought to the laboratory (3).

IV. RESEARCH METHODOLOGY

4.1 Phyco-remediation set-up for Industrial effluent by micro-algae

This study helps to evaluate the potential of chosen algae strains for phyco-remediation of industrial effluent. A set of 1 lit of raw effluent from textile industry were taken for phyco-remediation in conical flask without adding nutrients. 10 ml of uniform suspension of pure culture of algae as initial inoculums (25 days old culture) were added in each flask. The setup was kept on tissue culture rack and artificial white cool fluorescent light was provided for LD of 10 hours per day. The flasks were hand shaken twice a day for exchange of gases and to avoid sticking algae on wall. The experimental set-up were kept for 20 days (Fig. 5.1). The parameters pH, Electrical Conductivity, Temperature, Turbidity, TS and TDS, Acidity, Alkalinity, Dissolved Oxygen, Chemical Oxygen Demand, Biochemical Oxygen demand, Sulphate, Phosphate, Total Nitrogen, Total Hardness & Calcium Hardness, Chlorides and Iron were monitored periodically after 5 day interval.

The initial parameters of each industrial effluent were analyzed before adding algae and the same parameters were examined after interval of 5 day. To support the current research set-up, bioremediation of sewage water by adding 2 ml of pure inoculums of *C. vulgaris* and *S. quadricauda* in 200 ml for 20 days and periodically after every 5 day interval the treated effluent was analyzed in controlled condition was studied (4).

4.2 Statistical tool and Data interpretation

The sets was kept in triplicate to get research data expressed by means of mean ± SD. The one tailed paired Student's t-test was used to determine to study the statistical significance between the untreated and treated parameters with $p<0.05$. (4 & 5)

Mean and standard deviation were calculated with the help of MS Excel 2007. Student t-test was calculated with the help of Graphpad prism version 8.4.3. and the percentage removal efficiency was calculated with following formula (6)

$$\text{Removal Efficiency (\%)} = \frac{Ci - Ce \times 100}{Ci}$$

Where,
Ci = Concentration of the parameter before phyco-remediation
Ce = Concentration of the parameter after phyco-remediation using algal species.

V. RESULTS AND DISCUSSION

5.1 Study of efficiency of Consortium of BGA: The effects of phyco-remediation on Morarjee Textile effluent by using consortium of BGA are as follows

pH: The initial pH of effluent was 7.86 ± 0.096 and change recorded from 8.03 ± 0.07, 8.42 ± 0.11, 9.11 ± 0.12 to 9.36 ± 0.13 at 5th, 10th, 15th and 20th day of phyco-remediation. The percentage changes in pH were -2.12%, -7.12%, -15.81% and -19.07% respectively. The pH value of treated effluent was observed slightly above the permissible limit according to BIS and ISI standards (Table 5.5). The results are statistically significant as the p value obtained is 0.0004. To support the present study, increase in pH was reported after phyco-remediation of textile dye effluent (7).

Electrical Conductivity: The electrical conductivity values of Morarjee textile was decreased from 1.746 ± 0.0075, 1.729 ± 0.005, 1.700 ± 0.01, 1.611 ± 0.01 to 1.492 ± 0.02 ds m-1. The percentage reduction efficiency in electrical conductivity was observed 0.42%, 2.05%, 7.17% and 14.05% after 5th, 10th, 15th and 20th days of treatment. The absorption of ionic contents by algae may be the cause of reduction of EC. The results are statistically significant as the p value obtained is 0.0011.

Turbidity: High decrease in turbidity values was noted from 7 ± 1.00, 5.33 ± 0.58, 3 ± 1.00, 0.67 ± 1.15, to 0.33 ± 0.58 NTU at 1st, 5th, 10th, 15th and 20th day of treatment. The percentage removal of turbidity of Morarjee textile was recorded 23.41%, 57.14%, 91.67% and 95.83%. The results are statistically significant as the p value obtained is 0.0025.

Total Solids: The reduction in Total solids of Morarjee textiles were observed 2180 ± 10, 2150 ± 10, 1997 ± 15.28, 1950± 10 to 1820 ± 10 mg/L after phyco-remediation. The removal efficiency of total solids observed was 1.37%, 8.40%, 10.54% and 16.51% at 5th, 10th, 15th and 20th days of treatment. The significant p value of the result was not obtained due to same difference were noted in triplet.

Total Dissolved Solids: After remediation the decrease in Total dissolved solids was noted 1830 ± 10, 1810 ± 10, 1740 ± 10, 1660 ± 10 to 1500 ± 10 mg/L at 1st, 5th, 10th, 15th and 20th day of treatment. The reduction efficiency of consortium of BGA for removing TDS was 1.09%, 4.91%, 9.28%, 18.03%. The value of treated effluent was observed within the permissible limit comparing with BIS and ISI standards (Table 5.5). The results are statistically significant as the p value obtained is 0.0003. Treated tannery effluent where TDS values reduced by 14% after phyco-remediation; this result is confirmatory with the present study (8).

Alkalinity: The slightly decrease in alkalinity value was noted from 577 ± 5.77, 570 ± 10, 523 ± 11.55, 493.33 ± 15.28 to 470 ± 10 mg/L. After phyco-remediation the removal efficiency of alkalinity recorded was 1.16%, 9.25%, 14.45%, 18.50% at 5th, 10th, 15th and 20th days of treatment. The results are statistically significant as the p value obtained is 0.0010.

DO: The value of DO increased from 0.00, 0.00, 1.70 ± 0.20, 3 ± 0.20 to 4.50 ± 0.26 mg/L at 1st, 5th, 10th, 15th and 20th day of treatment after phyco-remediation. The progressively increase in DO obtained was 0%, 17%, 30% and 45 %. The increase in DO may be due to presence of phyto-plankton in form of algae. The results are statistically significant as the p value obtained is 0.0012. The increase in DO 21.46% of sugar industries after 60 days of phyco-remediation with Spirogyra sp. was reported, which support the present study (9).

COD: The COD values show maximum reduction from 872 ± 8, 594.67 ± 12.22, 395 ± 12.22, 160 ± 8 to 88 ± 8 mg/. The COD reduction efficiency was noted 31.80%, 54.73%, 81.64% and 89.91% at 5th, 10th, 15th and 20th days of treatment. The value of treated effluent was observed within the permissible limit according to BIS and ISI standards (Table 5.5). The significant p value was not obtained due to same difference were noted in triplet. The reduction in COD is likely due to absorption of organic nutrients from Morarjee Textile effluent by algae. The supportive finding to this study was reported decrease in COD in textile dye effluent when treated with *Sprirulina platensis* (10).

BOD: The BOD of Morarjee Textile effluent was reduced from 159 ± 8.08, 141 ± 6, 102 ± 4, 80 ± 7.21 to 55 ± 9.64 mg/L with phyco-remediation process at 1st, 5th, 10th, 15th and 20th day. The BOD removal efficiency observed was 11.48%, 35.90%, 49.82% and 65.62%. The value of BOD of treated effluent was noted above the permissible limit for inland surface water according to BIS and IS

standards, but as per BIS standards for inland irrigation BOD value was in limit (Table 5.5). The results are statistically significant as the p value obtained is 0.0002.

Sodium and Potassium: The values of Sodium and Potassium after phyco-remediation were decreased from 37.33 ± 0.58, 23 ± 3, 12 ± 1, 5.67 ± 0.58 to 1.33 ± 0.58 mg/L and 8.33 ± 0.58, 7.67 ± 0.58, 3.67 ± 0.58, 0.00 to 0.00 mg/L respectively. The Sodium and Potassium removal efficiency by consortium of BGA were noted 38.30%, 67.82%, 84.82%, 96.41% and 7.87%, 56.02%, 100%, 100% respectively at 5th, 10th, 15th and 20th days of treatment. The results are statistically significant as the p value obtained was 0.0003 and 0.0016 for sodium and potassium.

Sulphate: The reduction observed in Sulphate value was 41 ± 2.31, 38.33 ± 1.15, 24.67 ± 1.15, 21.33 ± 0.58 to 13.33 ± 0.58 mg/L at 1st, 5th, 10th, 15th and 20th day of treatment. The phyco-remediation efficiency of consortium of BGA was 5.64%, 39.26%, 47.45% and 67.16% for removal of Sulphate. According to BIS and ISI standards the values of treated effluent was observed within the permissible limit (Table 5.5). The results are statistically significant as the p value obtained is 0.0019.

Phosphates: Phosphate reduction was observed from 6.67 ± 0.58, 6.67 ± 0.58, 6.53 ± 0.46, 5.67 ± 0.58 to 5.67 ± 0.58 mg/L. The removal efficiency recorded was 0.00%, 1.90%, 15.07% and 15.07% of Phosphate from Morarjee Textile effluent at 5th, 10th, 15th and 20th days of treatment. The significantly p value was not obtained due to same difference were noted of triplet. Similar trend was noted highest reduction potential to remove phosphate with *Nostoc, Oscillotoria* and *Glococapsa* from industrial effluent (11).

Total Kjeldal Nitrogen: The reduction of total nitrogen was recorded 59 ± 2.80, 51.33 ± 1.62, 42 ± 2.80, 33.60 ± 2.80 to 25.20 ± 2.80 mg/L at 1st, 5th, 10th, 15th and 20th day of treatment. The TKN reduction efficiency noted was 12.64%, 28.61%, 42.92% and 57.23%. The value of treated effluent was observed within the permissible limit comparing with BIS and ISI standards (Table 5.5). The significantly p value was not obtained due to same difference in triplet. According to the researcher, it has been observed that microalgae takes all form of nitrogen as a nutrient, the most common assimilated nitrogen compounds are nitrate and ammonia (12).

Iron: Iron was completely removed by consortium of BGA from 2.67 ± 0.40, 1.73 ± 0.40, 1.01 ± 0.43, 0.00 to 0.00. The removal efficiency of Iron recorded was 34.74%, 62.50%, 100% and 100% at 5th, 10th, 15th and 20th days of treatment. The results are statistically significant as the p value obtained is 0.0076. The significant absorption in reduction of iron content was likely due to phyco-remediation treatment by consortium of BGA.

The physico-chemical characteristics before and after bio-remediation of Morarjee Textile effluent was listed in Table 5.1. The % removals efficiency during phyco-remediation of Morarjee Textile using Consortium of BGA are depicted in Table 5.2

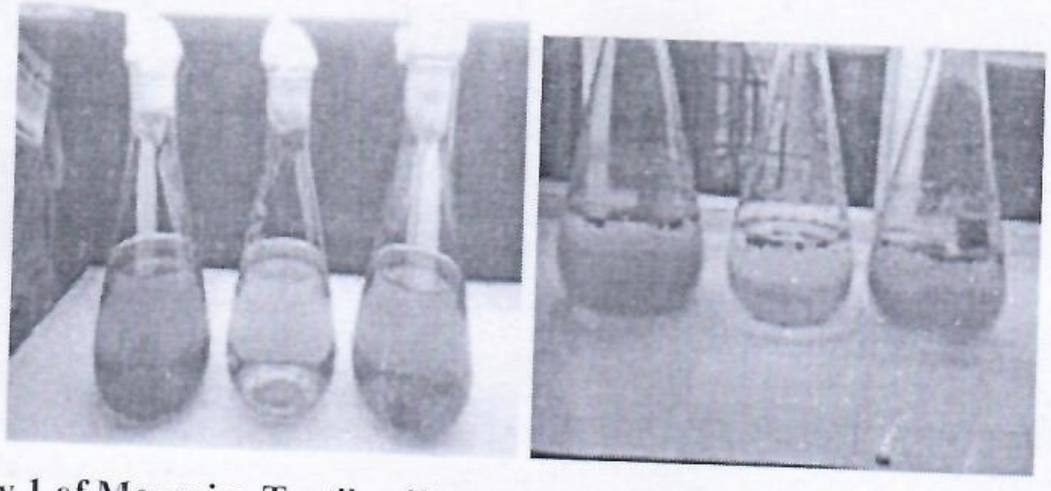

Plate 5.1: Comparison of Day 1 of Morarjee Textile effluent with Day 20 after phyco-remediation by consortium of BGA

Table 5.1: Physico-chemical analysis before and after treatment of Morarjee textile effluent by consortium of BGA

Parameters	Initial	Average mean			
Days		5th	10th	15th	20th
pH	7.86 ± 0.096	8.03 ± 0.07	8.42 ± 0.11	9.11 ± 0.12	9.36 ± 0.13
Conductivity	1.746 ± 0.0075	1.729 ± 0.005	1.700 ± 0.01	1.611 ± 0.01	1.492 ± 0.02
Turbidity	7 ± 1.00	5.33 ± 0.58	3 ± 1.00	0.67 ± 1.15	0.33 ± 0.58
Total solids	2180 ± 10	2150 ± 10	1997 ± 15.28	1950 ± 10	1820 ± 10
TDS	1830 ± 10	1810 ± 10	1740 ± 10	1660 ± 10	1500 ± 10
Alkalinity	577 ± 5.77	570 ± 10	523 ± 11.55	493.33 ± 15.28	470 ± 10
DO	0.00	0.00	1.70 ± 0.20	3 ± 0.20	4.50 ± 0.26
COD	872 ± 8	594.67 ± 12.22	395 ± 12.22	160 ± 8	88 ± 8
BOD	159 ± 8.08	141 ± 6	102 ± 4	80 ± 7.21	55 ± 9.64
Sodium	37.33 ± 0.58	23 ± 3	12 ± 1.00	5.67 ± 0.58	1.33 ± 0.58
Potassium	8.33 ± 0.58	7.67 ± 0.58	3.67 ± 0.58	0.00	0.00
Sulphate	41 ± 2.31	38.33 ± 1.15	24.67 ± 1.15	21.33 ± 0.58	13.33 ± 0.58
Phosphate	6.67 ± 0.58	6.67 ± 0.58	6.53 ± 0.46	5.67 ± 0.58	5.67 ± 0.58
T. Nitrogen	59 ± 2.80	51.33 ± 1.62	42 ± 2.80	33.60 ± 2.80	25.20 ± 2.80
Iron	2.67 ± 0.40	1.73 ± 0.40	1.01 ± 0.43	0.00	0.00

Note: All values are expressed in mg/L except pH, EC and Turbidity

Table 5.2: % removal efficiency of Morarjee Textile effluent by consortium of BGA

Parameters	% Removal			
Days	5th	10th	15th	20th
pH	-2.12	-7.12	-15.81	-19.07
Conductivity	0.42	2.05	7.17	14.05
Turbidity	23.41	57.14	91.67	95.83
Total solids	1.37	8.40	10.54	16.51
TDS	1.09	4.91	9.28	18.03
Alkalinity	1.16	9.25	14.45	18.50
DO	0.00	17.00	30.00	45.00
COD	31.80	54.73	81.64	89.91
BOD	11.48	35.90	49.82	65.62
Sodium	38.30	67.82	84.82	96.41
Potassium	7.87	56.02	100	100
Sulphate	5.64	39.26	47.45	67.16
Phosphate	0.00	1.90	15.07	15.07
Total Nitrogen	12.64	28.61	42.92	57.23
Iron	34.74	62.50	100	100

5.2 Study of Consortium of Chlorophyta: The phyco-remediation study shown that,

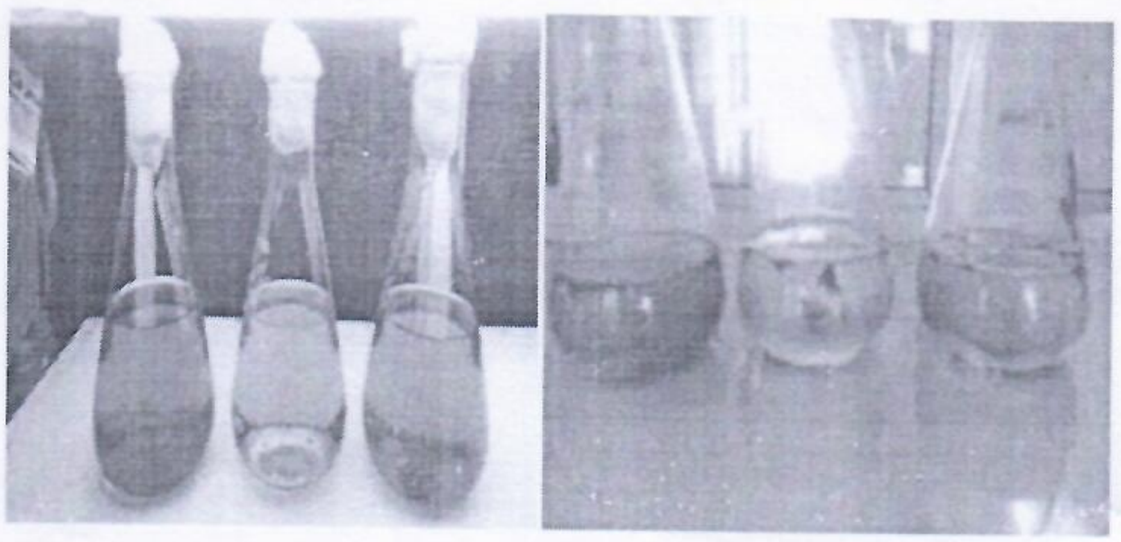

Plate 5.2: Comparison of Day 1 of Morarjee Textile effluent with Day 20 after phyco-remediation by consortium of Chlorophyta

pH: The result shown that pH was increased from 7.86 ± 0.04, 8.06 ± 0.07, 8.34 ± 0.09, 8.85 ± 0.08 to 9.16 ± 0.07 at 1th, 5th, 10th, 15th and 20th day after treatment with consortium of Chlorophyta. The increases in removal efficiency of pH were recorded -2.63%, -6.15%, -12.68% and -16.54%. According to BIS and ISI standards the value of treated effluent was observed slightly above the permissible limit (Table 5.5). The results are statistically significant as the p value obtained is 0.0002. Similar increase in pH was also reported of tannery effluent after phyco-remediation (13).

Electrical Conductivity: The electrical conductivity decreased from 1.728 ± 0.004, 1.720 ± 0.002, 1.688 ± 0.01, 1.616 ± 0.01 to 1.468 ± 0.01 ds m^{-1}. The reduction of electrical conductivity was observed 0.50%, 2.31%, 6.50%, 15.04% at 5th, 10th, 15th and 20th days of treatment. The results are statistically significant as the p value obtained is 0.0003. Treated textile effluent with *Chlorella pyrenoidosa* and recorded reduction in EC by 10.76% which is slightly corroborated with present study (14).

Turbidity: The turbidity was totally removed from 7.67 ± 0.58, 5 ± 0.00, 2.67 ± 1.15, 0.00 to 0.00 NTU at 1th, 5th, 10th, 15th and 20th day after treatment with consortium of Chlorophyta. Turbidity removal efficiency of Morarjee textile was 34.52%, 64.28%, 100%, 100%. The results are statistically significant as the p value obtained is 0.0019.

Total solids: The total solids were decreasing from 2180 ± 10, 2130 ± 10, 1970 ± 10, 1930 ± 10 to 1800 ± 10 mg/L. The reduction efficiency of total solids was 2.29%, 9.63%, 11.46% and 17.43% at 5th, 10th, 15th and 20th days of treatment. The results are statistically significant as the p value obtained is 0.0002.

TDS: The total dissolved solids reduced with consortium of Chlorophyta was 1830 ± 10, 1803.33 ± 5.77, 1720 ± 10, 1643.3 ± 5.77 to 1480 ± 10 mg/L at 1th, 5th, 10th, 15th and 20th day after treatment. The total dissolved solids removal efficiency were noted 1.45%, 6%, 10.20% and 19.17% for Morarjee textile effluent. As per BIS and ISI standards the value of treated effluent was observed within the permissible limit (Table 5.5). The significant p value was not obtained due to same difference in triplet. Similar findings in line noted 61.71% and 61.38% reduction of TDS with *Chlorella vulgaris* and *Scenedesmus obliquus* respectively in textile dye effluent (15).

Alkalinity: The decrease in alkalinity was observed 613.3 ± 5.77, 546.67 ± 5.77, 513.33 ± 5.77, 480 ± 0.00 to 460 ± 0.00 mg/L. The percentage removal of alkalinity was 10.86%, 16.29%, 21.73% and 24.99% at 5th, 10th, 15th and 20th days of treatment. The results are statistically significant as the p value obtained is 0.0005

DO: The value of DO were increased from 0.00, 0.00, 1.77 ± 0.06, 3.63 ± 0.15 to 4.90 ± 0.20 mg/L at 1th, 5th, 10th, 15th and 20th day after treatment. The increased efficiency of consortium of Chlorophyta was 0.00%, 17.70%, 36.30%, 49%. The results are statistically significant as the p value obtained is 0.0006. The increase in DO in textile effluent after treated with *Phormidium valderianum* was noted (16).

COD: The COD values were decreased from 845.33 ± 12.22, 576 ± 8.00, 370.67 ± 12.22, 144 ± 8.00 to 72 ± 8.00 mg/L. The removal efficiency of consortium of Chlorophyta was noted 31.86%, 56.16%, 82.95% and 91.48% at 5th, 10th, 15th and 20th days of treatment. The value of treated effluent was observed within the permissible limit according to BIS and ISI standards (Table 5.5). The results are statistically significant as the p value obtained is 0.0002. Suitability of *Lemnaminuta Lin* for removing colour along with other parameter from textile industry wastewater, where COD was removed by 81.9%, in line with the present study (17).

BOD: After phyco-remediation of textile effluent the BOD was reduced from 158 ± 4.00, 135 ± 3.00, 106 ± 5.29, 74 ± 2.00 to 33 ± 3.00 mg/L at 1th, 5th, 10th, 15th and 20th day after treatment. The reduction efficiency of BOD was 14.53%, 32.83%, 53.15% and 79.12%. The BOD value of treated effluent was observed within the permissible limit comparing with BIS and ISI standards (Table 5.5). The results are statistically significant as the p value obtained is 0.0003. Treated textile effluent with *Chlorella pyrenoidosa* reduces BOD by 73.16%, result affirms to the present study (14).

Sodium and Potassium: The Sodium values reduced from Morarjee textile effluent was recorded 43.33 ± 0.58, 27 ± 1.00, 12 ± 1.00, 4.33 ± 0.58 to 0.67 ± 0.58 mg/L and Potassium was 10.33 ± 0.58, 6.33 ± 0.58, 2.67 ± 0.58, 0.00 to 0.00 mg/L. The sodium removal efficiency was 37.66%, 72.32%, 89.99% and 98.46% for potassium was 38.48%, 74.24%, 100% and 100% respectively at 5th, 10th, 15th and 20th days of treatment. The results are statistically significant as the p value obtained is <0.0001 for sodium and 0.0010 for potassium.

Sulphate: The decrease in sulphate value was observed from 44 ± 1.00, 36 ± 1.00, 22.67 ± 0.58, 19.33 ± 1.53 to 9.67 ± 1.15 mg/L at 1th, 5th, 10th, 15th and 20th day after treatment. The increase in reduction efficiency for sulphate was noted 18.12%, 48.48%, 56.03% and 78.02%. The value of treated effluent was observed within the permissible limit according to BIS and ISI standards (Table 5.5). The results are statistically significant as the p value obtained is 0.0007. To corroborate the present work, high removal of sulphate with consortium of *Chlorella* and *Scenadesmus* was reported (15).

Phosphates: The Phosphate of the effluent was decreased from 8.33 ± 0.58, 6.17 ± 0.06, 5.67 ± 0.58, 4.33± 0.58 to 4 ± 0.00 mg/L. The phosphate removal efficiency of consortium of Chlorophyta was 25.74%, 31.94%, 47.68% and 51.85% at 5th, 10th, 15th and 20th days of treatment. The results are statistically significant as the p value obtained is 0.0059. Treated textile effluent with *Chlorella pyrenoidosa* were phosphate was reduced by 36.36%, the finding substantiate with current work (14).

Total K. Nitrogen: The reduction of total nitrogen was noted 51.60 ± 14.96, 45.73 ± 1.62, 36.40 ± 2.80, 27.07 ± 3.23 to 14 ± 2.80 mg/L at 1th, 5th, 10th, 15th and 20th day after treatment. The removal efficiency of total nitrogen was observed 25.65%, 40.96%, 56% and 77.31%. According to BIS and ISI standards the value of treated effluent was observed within the permissible limit (Table 5.5). The results are statistically significant as the p value obtained is 0.0069. Consortium of *Chlorella, Chlamydomonas, Scenedesmus, Gloeocyctis* to treat Carpet mill effluent along with sewage from Dalton area in North Central Georgia showed 98% Nitrogen and 75% Phosphate removal (18).

Iron: Iron was removed completely from Morarjee Textile effluent the observed values was 3.03 ± 0.15, 1.57 ± 0.15, 0.75 ± 0.06, 0.00 to 0.00 mg/L. The increase in removal efficiency of iron was 48.13%, 75.77%, 100% and 100% at 5th, 10th, 15th and 20th days of treatment. The results are statistically significant as the p value obtained is 0.0008.

Table 5.3: Physico-chemical analysis before and after treatment of Morarjee textile effluent by consortium of Chlorophyta

Parameters	Initial	Average mean			
Days		5th	10th	15th	20th
pH	7.86 ± 0.04	8.06 ± 0.07	8.34 ± 0.09	8.85 ± 0.08	9.16 ± 0.07
Conductivity	1.728 ± 0.004	1.720 ± 0.002	1.688 ± 0.01	1.616 ± 0.01	1.468 ± 0.01
Turbidity	7.67 ± 0.58	5 ± 0.00	2.67 ± 1.15	0.00	0.00
Total solids	2180 ± 10	2130 ± 10	1970 ± 10	1930 ± 10	1800 ± 10
TDS	1830 ± 10	1803.33 ± 5.77	1720 ± 10	1643.3 ± 5.77	1480 ± 10
Alkalinity	613.3 ± 5.77	546.67 ± 5.77	513.33 ± 5.77	480 ± 0.00	460 ± 0.00
DO	0.00	0.00	1.77 ± 0.06	3.63 ± 0.15	4.90 ± 0.20
COD	845.33 ± 12.22	576 ± 8.00	370.67 ± 12.22	144 ± 8.00	72 ± 8.00
BOD	158 ± 4.00	135 ± 3.00	106 ± 5.29	74 ± 2.00	33 ± 3.00
Sodium	43.33 ± 0.58	27 ± 1.00	12 ± 1.00	4.33 ± 0.58	0.67 ± 0.58
Potassium	10.33 ± 0.58	6.33 ± 0.58	2.67 ± 0.58	0.00	0.00
Sulphate	44 ± 1.00	36 ± 1.00	22.67 ± 0.58	19.33 ± 1.53	9.67 ± 1.15
Phosphate	8.33 ± 0.58	6.17 ± 0.06	5.67 ± 0.58	4.33 ± 0.58	4 ± 0.00
Total Nitrogen	58.27± 3.63	45.73 ± 1.62	36.40 ± 2.80	27.07 ± 3.23	14 ± 2.80
Iron	3.03 ± 0.15	1.57 ± 0.15	0.75 ± 0.06	0.00	0.00

Note: All values are expressed in mg/L except pH, EC and Turbidity

Table 5.4:% removal of parameters of Morarjee Textile effluent by consortium of Chlorophyta

Parameters	% Removal			
Days	5th	10th	15th	20th
pH	-2.63	-6.15	-12.68	-16.54
Conductivity	0.50	2.31	6.50	15.04
Turbidity	34.52	64.28	100	100
Total solids	2.29	9.63	11.46	17.43
Total Dissolved Solids	1.45	6	10.20	19.17
Alkalinity	10.86	16.29	21.73	24.99
Dissolved Oxygen	0.00	17.70	36.30	49.00
Chemical Oxygen Demand	31.86	56.16	82.95	91.48
Bio-chemical Oxygen Demand	14.53	32.83	53.15	79.12
Sodium	37.66	72.32	89.99	98.46
Potassium	38.48	74.24	100	100
Sulphate	18.12	48.48	56.03	78.02
Phosphate	25.74	31.94	47.68	51.85
T. Nitrogen	25.65	40.96	56	77.31
Iron	48.13	75.77	100	100

5.3 Comparison of outcome with BIS and ISI standards

All the parameters of Morarjee textile treated effluent except pH and BOD was in permissible limit as per BIS & ISI standards after phyco-remediation. The pH of treated effluent was noted 9.36 & 9.16 and the standard limit is 5.5-9 which is slightly high. According the standards for inland surface water the BOD of treated effluent should be 30 but, whereas BOD value of treated effluent was observed 55 and 33 which is exceeding the limit. In case of irrigation discharge the BOD values are in permissible limit.

Table 5.5: Comparison of treated Morarjee textile effluent with BIS and ISI standards

Parameters	Treated Effluent with consortium of BGA	Treated Effluent with consortium of Chlorophyta	BIS standard (Into inland surface waters a)	BIS standard (On inland for irrigation c)	ISI standards (Industrial waste water in inland surface water IS: 2460-1974)
pH	**9.36**	**9.16**	5.5-9.0	5.5-9.0	5.5-9.0
Conductivity	1.492	1.468	-	-	-
Turbidity	0.33	0.00	-	-	-
Total Solids	1820	1800	-	-	-
TDS	1500	1480	2100	2100	-
Alkalinity	470	460	-	-	-
DO	4.50	4.90	-	-	-
COD	88	72	250	-	250
BOD	**55**	**33**	30	100	30
Sodium	1.33	0.67	-	-	-
Potassium	0.00	0.00	-	-	-
Sulphate	13.33	9.67	1000	1000	-
Phosphate	5.67	4	-	-	-
T. Nitrogen	25.20	14	100	-	-
Iron	0.00	0.00	-	-	-

VI. CONCULSION

The phyco-remediation study of textile effluent, the results revealed that both the algae have excellent potential to remove the inorganic and organic contains from the effluent. The pH was increased by -19.07%, EC was reduced by 14.05%, Turbidity 95.83%, TS 16.51%, TDS 18.03%, Alkalinity 18.50%, DO was increased by 45%, COD was reduced by 89.91%, BOD 65.62%, Sodium and Potassium 96.41% and 100%, Sulphate 67.16%, Phosphate 15.07%, Total Nitrogen 57.23% and Iron 100% with consortium of BGA. The removal efficiency of consortium of Chlorophyta were pH was increased by -16.54%, EC was reduced by 15.04%, Turbidity 100%, TS 17.43%, TDS 19.17%, Alkalinity 24.99%, DO was increased by 49%, COD decreased by 91.48%, BOD 79.21%, Sodium and Potassium 98.46% and 100%, Sulphate 78.02%, Phosphate 51.85% TKN 77.31% and Iron 100%.

VII. ACKNOWLEDGMENT

The authors wish to thank to the Principal, Sevadal Women's College, Nagpur for providing laboratory & library facilities & authority of Department of Science and Technology (DST-SERB), Govt. of India for supporting to the studies in parts with funds. The authors also acknowledge the officials of Morarjee textile for extending their cooperation for providing wastewater samples.

REFERENCES

[1] Dipak S. and Arti D., 2011, Assessment and treatment of municipal wastewater of Indore city of India, Archives of Applied Sciences Research, 3(1): 450-461.

[2] Velan M., Saravanane R., 2013, CO2 sequestration and treatment of municipal sewage by microalgae, International Journal of Innovative Technology and Exploring Engineering 2, 2278-3075.

[3] Sethupathy A., Subramanian Ashok V., Manikandan R., 2015, Phyco-remediation of sewage waste water by using micro-algal strains, International Journal of Engg. Innovation and Research, Vol. 4, Issue 2, ISSN: 2277-5668.

[4] KshirsagarAyodhya D., Bioremediation of wastewater by using microalgae: an experimental study, International Journal of life sciences biotechnology and pharma research, July 2013, ISSN 2250-3137, Vol. 2, No. 3, pp 339-344.

[5] Vidhya K., J. Gopinath M., Agilan M., Phytoremediation of domestic waste water of Gandhi nagar, Vellore using microalgae Chlorella vulgaris, International Journal of applied research, 2017; 3(3): 770-773, ISSN no. 2394-5869.

[6] Hurst (1997), Water Microbiology in Public Health Manual of Environmental Microbiology, ASM Press, Washington, DC.

[7] Sivakumar K. K., Balanurugan C., Ramakrishnan D., and Leena H. B., (2011), Assessment studies on wastewater pollution by textile dyeing and bleaching industries at Karur, Tamil Nadu, Rasayan Journal Chemistry, 4(2): 264-269.

[8] Hanumantha Rao P., Ranjith Kumar R., Raghavan B., Subramanian V., Sivasubramaniam V., 2011, Application of phycoremediation technology in the treatment of wastewater from a leather-processing chemical manufacturing facility, Water Sa 37:7-17.

[9] Kumar V., Gautam P., Singh J., Thakur R., Assessment of phyco-remediation efficiency of spirogyra sp. using sugar mill effluent, International Journal of Environment, agriculture & biotechnology, Vol. 1, Issue-1, May-June-2016, ISSN:2456-1878, pp 54-60.

[10] Sivakalai, S. N. and Ramanathan, N., Romanian Journal (2013), Textile wastewater following purge with Spirulinaplatensis, Biophys., 23 91-20: 27-34.

[11] Dubey S. K., Dubey J., Mehra S., Tiwari P., and Bishwas A. J., (2011) Potential use of cynobacteria species in bioremediation of industrial effluent, African Journal of Biotechnology, 10, 1125-1132.

[12] Oliver R. L. and Ganf, G. G., (2000), Freshwater bloom In: Whitton BA and Potts M (eds.), The Ecology of Cyanobacteria: their Diversity in Time and Space, Kluwer, Dordrecht, 149-194.

[13] Thorat S. P. and Wagh S. B., (1999), Physico chemical analysis of tannery water, Journal of Industrial pollution Control, 16(1): 107-109.

[14] Pathak V. V., Singh D. P., Kothari R. and Chopra A. K., 2014, Phycoremediation of textile wastewater by unicellular microalga Chlorella pyrenoidosa, Cellular and Molecular Biology, 60 (5): 35-40.

[15] Elumalai S., Saravanan G. K., Ramganesh S., Sakthivel R. and Prakasam V., (2013), Phycoremediation of textile dye industrial effluent from Tirupur district, Tamil Nadu, India, International Journal of Science Innovations and Discoveries, 3 (1): 31-37

[16] Shashirekha U., Dhanve R., and Jadhar J., (2008), Biodegradation of triphenyl methane dye cotton blue by Penicilliumochrochloron MTCC 517, Journal of Hazardous Materials, 157: 472-479.

[17] SivakumarDurairaj, (2014) Color removal from Textile industry wastewater using LemnaMinuta Lin, Recent Advances in Civil Engineering and Mechanics, ISBN 978-960-474-403-9, PP 255-261.

[18] Chinnasamy S., Bhatnagar A., Hunt R.W., Das K. C , 2010, Microalgae cultivation in wastewater dominated by carpet mill effluents for biofuel applications, Bioresource Technology 101: 3097-3105.